Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

JULY, 1960

ATTEND THE IRON & STEEL EXPOSITION

*Entry end of No. 4 continuous galvanizing line, Weirton Plant, Weirton Steel Company*

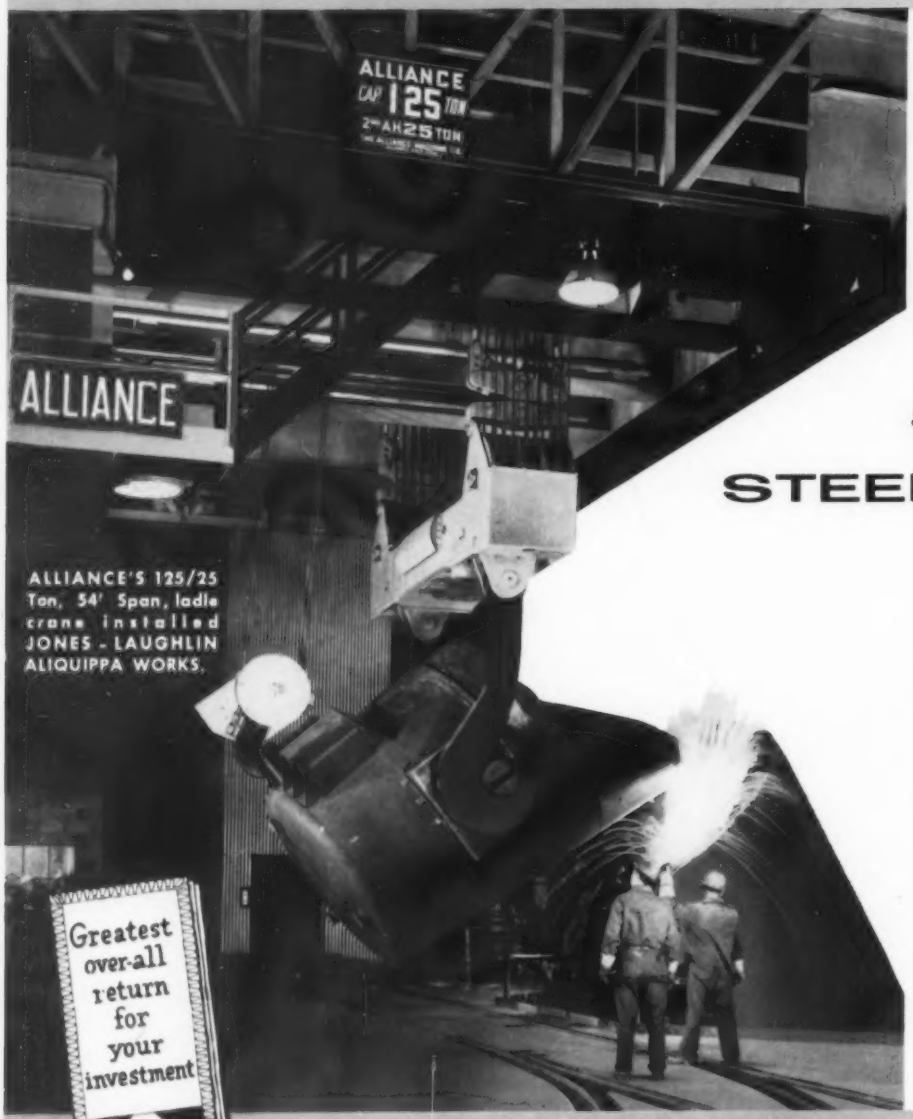
# Wean, Weirton and Galvanizing . . .

Weirton Steel Company, Division of National Steel Corporation, added this continuous hot-dip galvanizing line to meet the demand by customers for fine quality zinc-coated sheet. This line was specifically designed to process heavy gauge strip in widths up to 50", extending Weirton's coverage of finished sizes.

The Weirton line handles 65,000 pound coils and provides for either recoiling or shearing operations at the exit end. Shear lengths vary from 48" to 192". A horizontal cleaning section provides superior cleaning of the strip. Six bridles maintain continuous tension regulation throughout the line, permitting a wider range of gauges. Weirton's new galvanizing line is an example of Wean's *creative engineering*, oriented to solving a company's expansion needs. Why not take advantage of Wean's years of experience in your planning to meet expanding demand for galvanized products.

**THE WEAN ENGINEERING COMPANY, INC. · WARREN · OHIO**

# Partners in Progress....




ALLIANCE'S 125/25 Ton, 54' Span, ladle crane installed JONES - LAUGHLIN ALIQUIPPA WORKS.

## Alliance

## and the giant STEEL INDUSTRY

To date THE ALLIANCE MACHINE COMPANY has supplied the cranes for each and every L-D installation (Oxygen process) in the United States.

JONES AND LAUGHLIN has recently placed orders for four 300/50-Ton, 58', Span additional L-D cranes. These will be installed at the Cleveland plant. Throughout the years it is this confidence in Alliance's rugged workmanship, high quality, and product dependability that has built THE ALLIANCE MACHINE COMPANY.

For leadership, look to ALLIANCE for the greatest over-all return for your investment.

Greatest over-all return for your investment

"Give Us The Runway and We'll Lift The World"

Overhead Cranes * Gantry Cranes * Mill Cranes and Equipment * Hot Metal Cranes * Ladle Cranes Stripper Cranes * Soaking Pit Cranes * Soaking Pit Cover Cranes * Charging Machines * Furnace Chargers * Slab Handling Cranes * Bucket Cranes Magnet Cranes * Mold Yard Cranes * Skull Cracker Cranes * Ingot Buggies * Run-Out Tables Car Dumpers * Special Mill Equipment * Ore & Coal Bridges * Loading & Unloading Towers Forging Manipulators * Forging Cranes * Power House & Dam Cranes * Dock & Pier Handling Equipment * Research, Development & Engineering Service * Licensees & Manufacturing Facilities in Other Countries

the Alliance machine company

Main Office • Alliance, Ohio

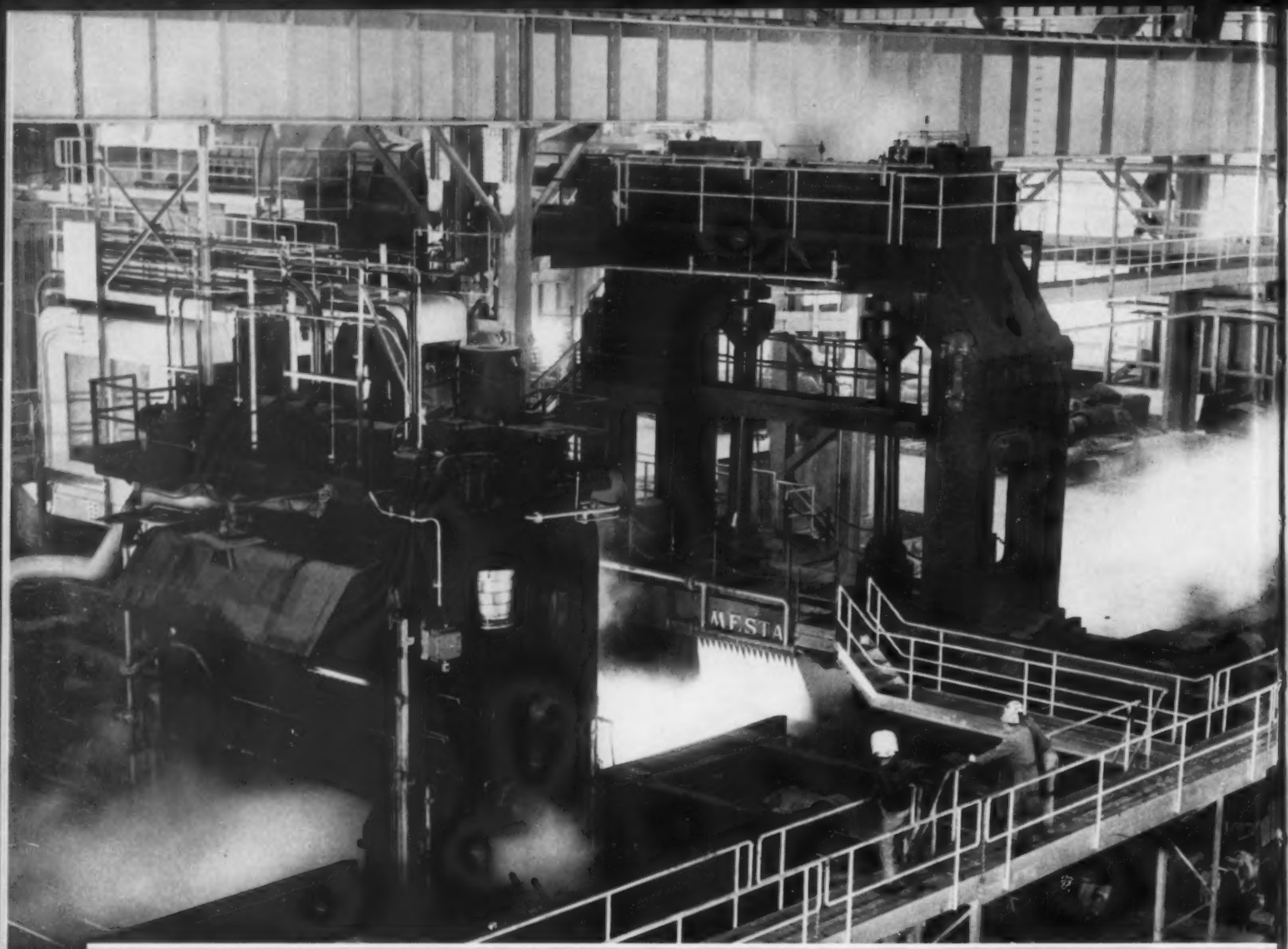
# *1,000 Feet of NORMALIZING LINE at Inland Steel*

This is another major unit in the continuing expansion program of Inland Steel Company of Chicago. The line normalizes cold rolled mild steel strip, 16 to 24 ga., 24 to 60″ wide, at furnace speed of 50 to 125 f. p. m. 60,000 lb. coils are fed into the line and 40,000 lb. coils are handled at the delivery end. Shearing facilities included in the line are suitable for sheets from 36″ to 192″.

Aetna-Standard's experience with Processing Lines dates back to the earliest production of strip in coils. This experience includes the design and building of many Continuous Electrolytic Tinning, Annealing and Normalizing Lines, as well as Continuous Galvanizing Lines. Aetna-Standard Division, Blaw-Knox Company, 300 Sixth Avenue, Pittsburgh, Pennsylvania.

*Aetna-Standard Division*

**BLAW-KNOX**

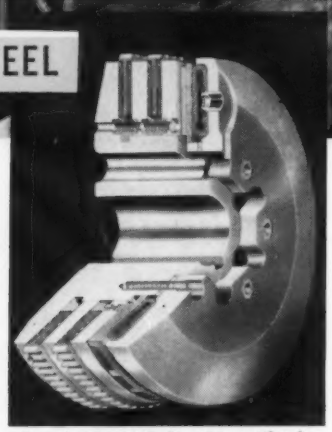



# 140 INCH MESTA SLABBING MILL WITH COMPACT, POWERFUL WICHITA CLUTCHES

## ON SCREW-DOWN SETS NEW WORLD STANDARD FOR LUKENS STEEL

**Outstanding feature of the horizontal mill is the screw-down drive with unique Wichita Clutches.**

In place of conventional magnetic or mechanical clutches, are a pair of Wichita Air-Tube Disc Clutches . . . transmitting torques of 9,000 ft.-lbs. to run the screws down. The clutches are normally open and do not rely on electric current for normal mill operation. In addition, they are more compact than conventional clutches and offer many safety features.



Standard Air-Tube Disc Clutch

For difficult or unusual clutching or braking problems it will pay you to call a Wichita Clutch engineer.

**Contact your nearest Wichita Engineer.**

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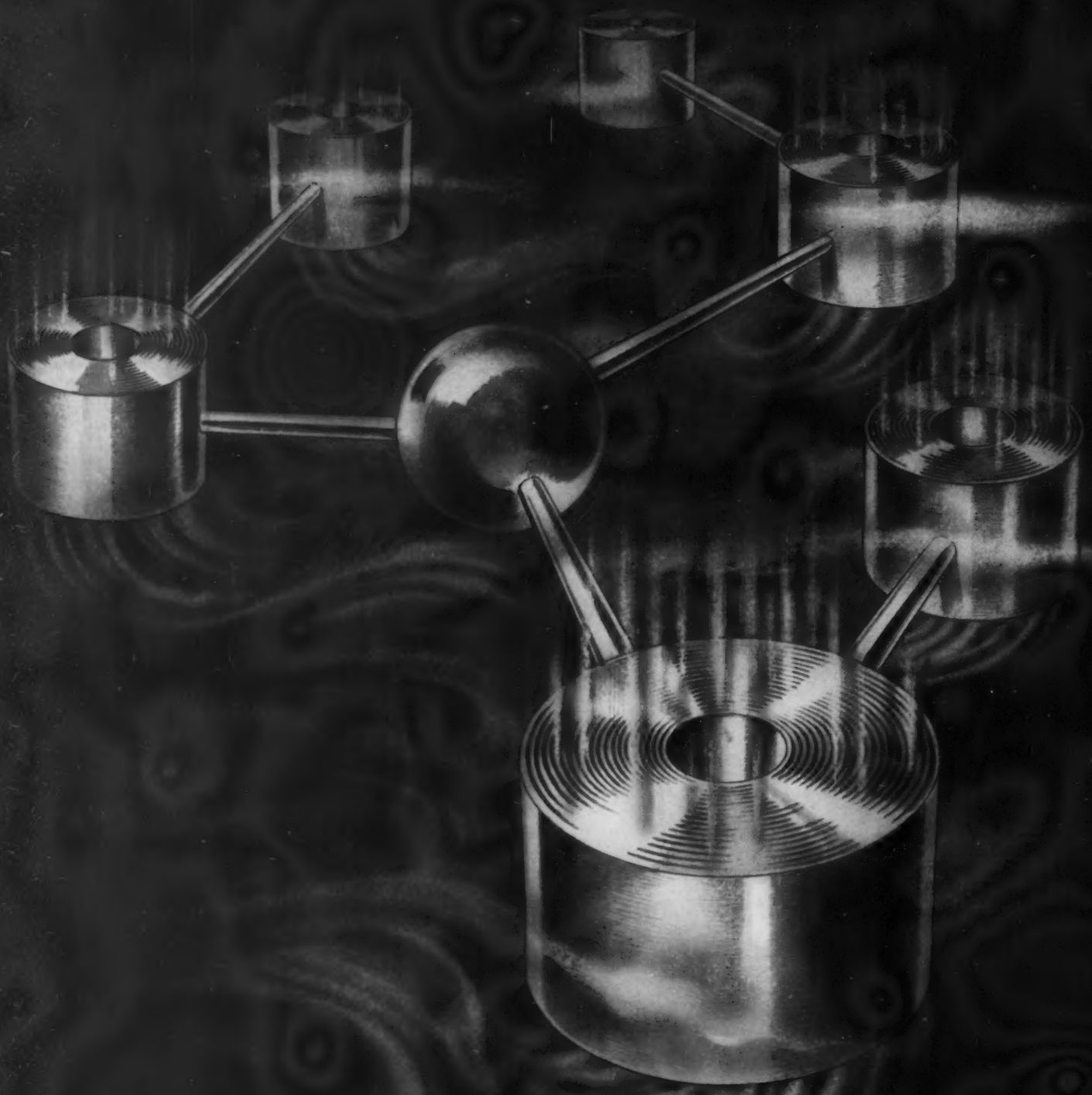
# Dramatic new method of alloying called. . . .



# ....THE GREATEST ADVANCE IN STEEL MAKING IN A DECADE

## Lee Wilson Open Coil Process of Gas Alloying advances an entirely new concept in steel chemistry!

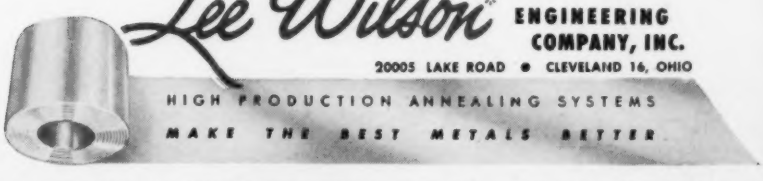
Now for the first time it is economically feasible to gas alloy steel in coil form at the annealing station. Lee Wilson engineers have successfully added or removed nitrogen and carbon by introducing gaseous elements during the annealing period. This opens up a whole new concept of steel alloying which will increase rolling mill efficiency, improve alloy uniformity, and save steel makers millions of dollars annually.

**How It Works**—Long a theory, gas alloying became possible when Lee Wilson engineers developed the first successful method for opening and handling opened coils at production rates. By threading a nylon cord or metal tape between each lamination of the coil, the coil is "opened" with an air space between each wrap. Thus the entire surface of the coil is open to special atmospheres which can be introduced during the annealing cycle, and any gas equilibrium reaction that exists within the area of the steel is at the correct temperature level for the constituents of the atmosphere gas and the interstituals in the steel. It is this compatibility of heat, atmosphere and steel composition that makes gas alloying possible.

**Field Tests Show Vast Potential**—Already actual field tests have shown that the Lee Wilson Process of Gas Alloying can produce a non-aging rimmed steel by reducing carbon and nitrogen. It also creates a vastly improved enamel iron product. By controlling the carbon content and grain structure in rimmed steel, a superior material for extra deep draw galvanized stock is produced. The removal of carbon and nitrogen in rimmed steels produces a strip of exceptional uniformity that can be substituted for low grade silicon sheet for motor laminations, and by reducing the carbon content in silicon sheet the electrical characteristics and surface conditions are substantially improved. By reversing the process, carbon and nitrogen can be restored to the steel in any desired quantities. By using the Open Coil Process, the Bessemer process can now produce sheet steels of equal quality to the open hearth process. This could save as much as 20% in the cost of many grades of sheet steel. At the coiling station such jobs as cleaning and inspection can be performed easily and automatically. Imaginative engineers and metallurgists immediately see many other advantages—many of which are undergoing tests in one or more of the pilot units now in the field. The potential of this new system now appears almost limitless.

**How To Learn More About It**—There is little wonder that an executive of one of the nation's leading steel makers called it "the greatest advance in steel making in the past decade" If you are not up to date on the Lee Wilson Open Coil Process of Gas Alloying why not let us arrange to have a Lee Wilson engineer meet with you at your convenience. We will have full particulars at our Booths 78,79 at the AISE Annual Convention and Iron and Steel Exposition in September. A full description, together with an animated motion picture, has been scheduled as a part of the program. Check your show schedules and plan now to attend.

*Patent Applied for*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MAKE THE BEST METALS BETTER

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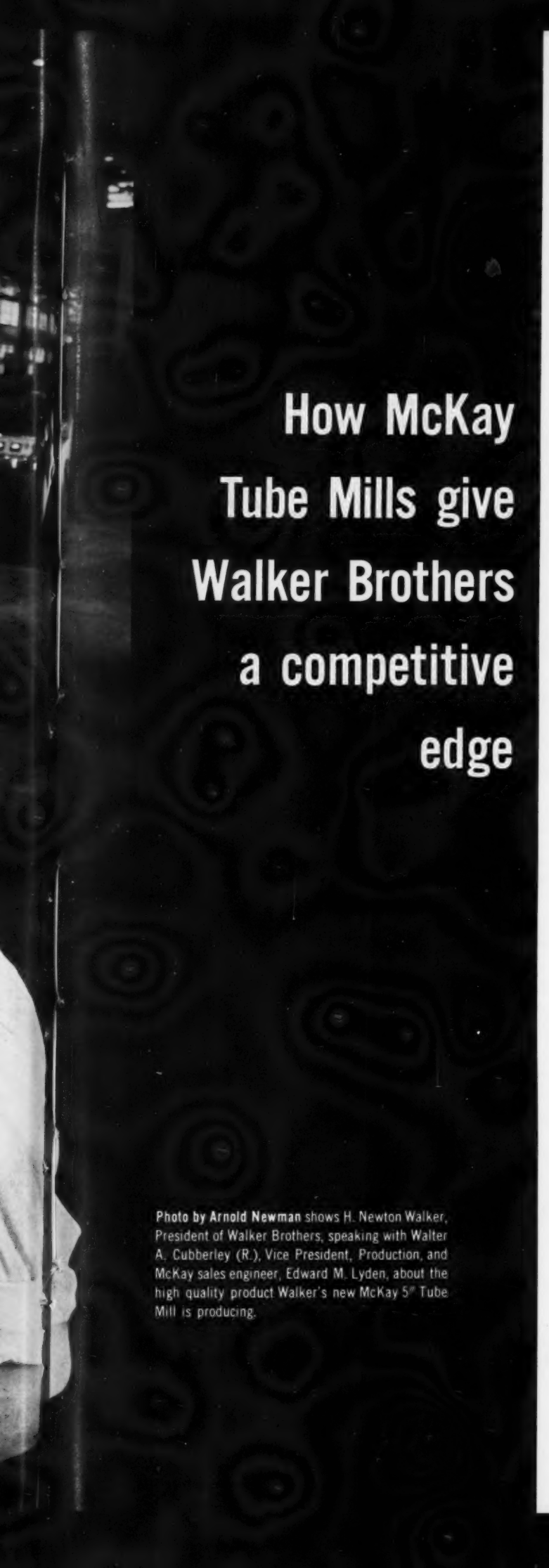


# How McKay Tube Mills give Walker Brothers a competitive edge

**Photo by Arnold Newman** shows H. Newton Walker, President of Walker Brothers, speaking with Walter A. Cubberley (R.), Vice President, Production, and McKay sales engineer, Edward M. Lyden, about the high quality product Walker's new McKay 5″ Tube Mill is producing.

"Our new McKay 5″ Tube Mill enables us to extend our production range to the larger sizes of Walkerduct and steel tubing. The mill affords close manufacturing tolerances and improved control over production schedules," says H. Newton Walker, President of Walker Brothers, Conshohocken, Pa.

**High Quality Product**—Walker Brothers has been a primary supplier of high quality electrical distribution materials to the commercial and industrial construction industry for fifty years. "Walker of Conshohocken" products include building wire, power and control cables, mechanical steel tubing, steel electrical metallic tubing, rigid steel conduit and underfloor raceways.

"This is the third McKay Tube Mill we have installed since 1951 to increase our capacity to manufacture conduit and raceways," continues Mr. Walker. "Each of these mills," he says, "has turned out a product consistent with our high standards of manufacture."

**Better Production Economies**— Walker Brothers has, in addition to the new McKay 5″ Tube Mill, two 3″-capacity McKay mills equipped with strip looping and welding equipment. These mills are generally used to produce ½″ through 2″ thin wall conduit on a continuous basis at a speed of 150 feet per minute. The new 5″ mill also operates at 150 F.P.M. and at that speed can easily produce Walker's line of 6.5″ x 1.5″ x .076″ rectangular raceway.

Mr. Walter Cubberley, Vice President, Production, states: "We have been most satisfied with the performance of this equipment. Performance of the McKay mill has more than met our expectations regarding versatility and cost savings."

**Low Maintenance Cost**—"There's something to be said for the design of this equipment, too," he says, "in that maintenance is, and has been, satisfactorily low regardless of the age of the machinery."

"This is very solid equipment, including the welder. In fact, I would say these are the best mills we could have selected for our type of operation," Mr. Cubberley concludes.

McKay Machine designs and builds electricweld tube mills for high speed production of ferrous and nonferrous welded tubing up to 20″ in diameter. The experience of nearly 25 years of pioneering in the design of tube making equipment is behind each modern McKay Tube Mill.

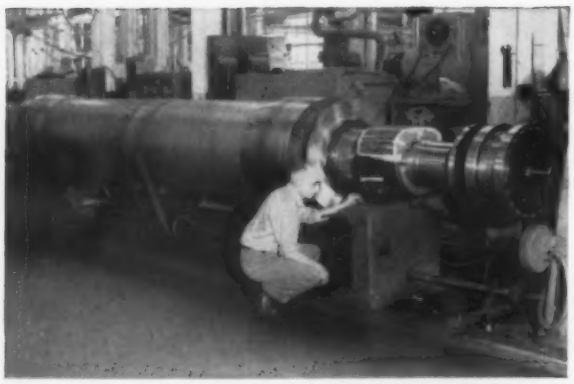
Write for literature, or send a description of your needs for prompt quotation to McKay Machine Company, Youngstown 1, Ohio.

LOOK TO

McKAY MACHINE

FOR PROGRESS IN METAL PROCESSING

# Thermal cycling ruined it...



Rewound rotor is balanced at National's plant to less than .0005" motion in free floating bearings. After complete testing, rotor was returned to service.

# National rebuilds 63,333-hp rotor to last

This rotor for a wind tunnel motor took unusual punishment. Since loading of the motor continually changed, the rotor was subjected to severe thermal cycling. Expansion and contraction of coils in the slots broke down the mica ground insulation.

National rewound the rotor with new coils insulated with glass-fiber and resin. New design slot troughs of high mechanical strength were used. Now the insulation wall is extremely tough, solid and durable.

Whether your electric coil and rebuilding needs are standard or special, you'll be sure of performance when you call in National Electric Coil. We tailor-make the coils to fit your needs; offer all types of insulation. For information call National's Columbus plant... HUdson 8-1151 ... or call the nearest National field engineer.

NATIONAL COILS

## National Electric Coil

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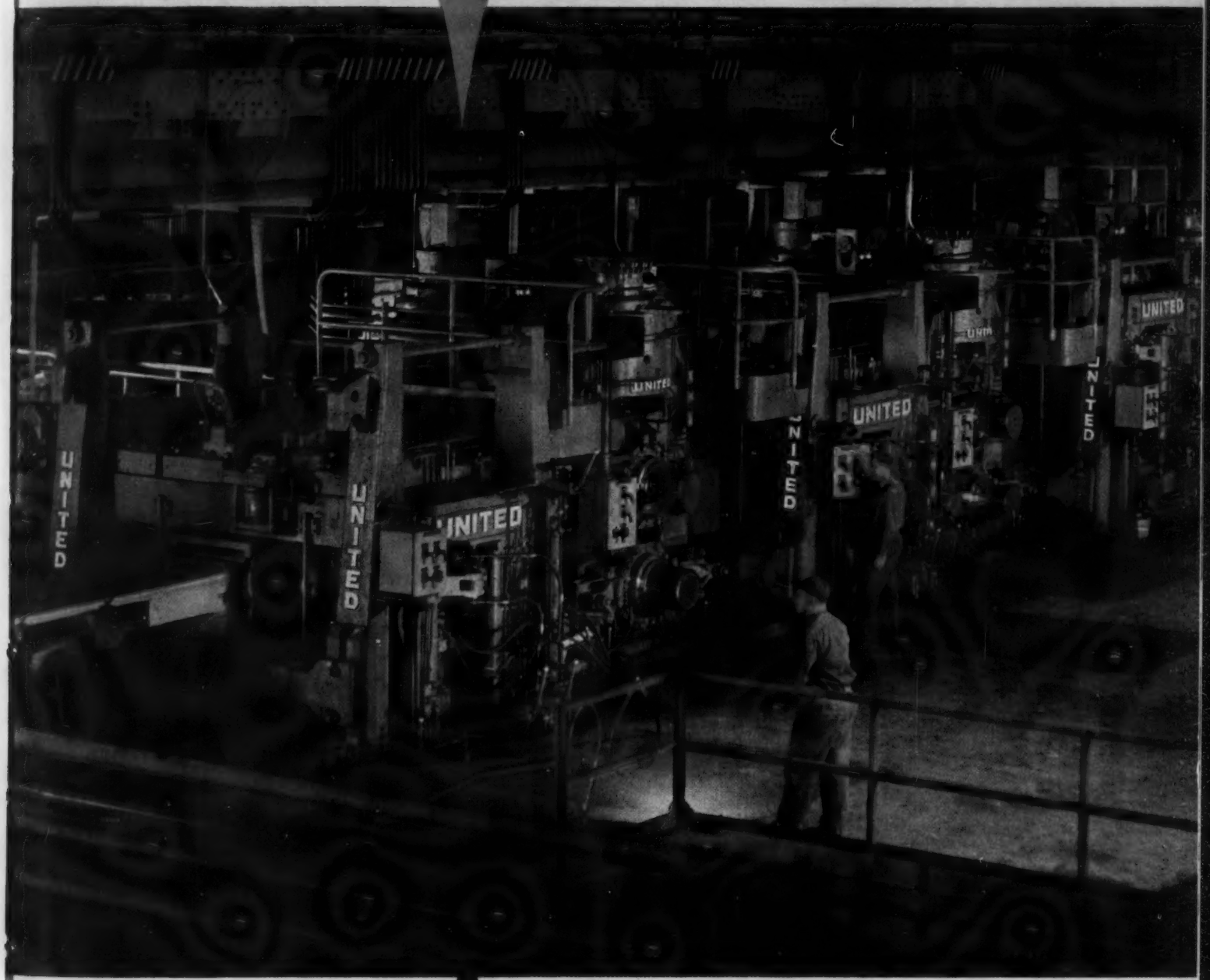
DIVISION OF McGRAW EDISON

# UNITED®

*6–Stand continuous horizontal and vertical Billet Mill*




**UNITED ENGINEERING AND FOUNDRY COMPANY**
**PITTSBURGH, PENNSYLVANIA**

*Plants at* Pittsburgh, Vandergrift, Youngstown, Canton, Wilmington

SUBSIDIARIES: Adamson United Company, Akron, Ohio; Stedman Foundry and Machine Co., Inc., Aurora, Indiana

Designers and Builders of Ferrous and Nonferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other heavy machinery. Manufacturers of Iron, Nodular Iron and Steel Castings and Weldments.

Cleveland Cranes
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STEEL MILL SERVICE
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# Crops *and* Shorts

△ A different operating environment in the Sixties has been forecast by The Value Line Investment Survey. Characteristics of the new and sterner era to which the industry must accustom itself according to the forecast are:

1. Intensified competition which will increasingly affect profitability in terms of plant location, product mix and manufacturing efficiency.
2. Continued high capital spending aimed at improving finishing facilities rather than increasing ingot capacity.
3. Fewer work stoppages and smaller wage increases. Labor will aim at a shorter work week and a "spread-the-work" policy.
4. A slow down of the wage-price spiral with fewer price increases.
5. Production will be geared more closely to the actual rate of steel consumption. The result will be fewer banner years but also fewer periods of inventory liquidation.

△ According to the American Iron and Steel Institute, hot rolled product capacity now totals 113,785,590 net tons a year. This figure is some 10,200,000 net tons higher than in 1957, the most recent year for which finishing capacity was tabulated. The hot rolled figures are related to ingot capacity or to the supply of semi-finished steel.

Capacities for hot rolled products are based on actual production. Under emergency conditions, the industry's maximum potential capacity for some products could be considerably higher assuming optimum use of all available mills with unlimited access to ingots.

△ The wife who knows where her husband's nickels are has nothing on the husband who knows where the maid's quarters are.

△ And then there's this recipe for making a peach cordial—Buy her a drink.

△ Despite the continued slide in production, many steelmen remain optimistic. Joseph L. Block, chairman, Inland Steel Co., for example, expects 1960 will be one of the industry's best production years, "with a bare possibility of topping the 1955 record ingot output of 117,000,000 tons." Mr. Block estimates that second half production will approximate 57,000,000 tons, bringing the year's total into a range of 115,000,000–118,000,000 tons.

△ The demand for executives to fill jobs paying $10,000 or more yearly with medium-sized companies will continue to hold up during the second half of 1960, according to a nation-wide survey of 191 firms averaging annual sales of $12,300,000. The poll shows a need for slightly over one executive per firm, just about the same ratio as was determined in an earlier survey of medium-sized companies. Both were conducted by Executive Manpower Corp., New York management recruitment firm.

The need for sales chiefs is leveling off slightly, although they are still most wanted (30.3 per cent of top jobs vs. 37.1 per cent last time). The most impressive climb, however, was in the category of manufacturing production executives, who rose to second place with a 22.9 per cent demand, up from a 15.6 per cent previously. Engineering executives, although now in third position, still reflected about the same strength (22.4 per cent vs. 21.9 per cent).

△ Not being blessed with do-it-yourself fever, we are in complete agreement with the fellow who said: "You can do a lot with an old house these days if you are handy with money."

△ According to *Powerfax,* there is one sure-fire way to test the merits of your favorite whiskey. You simply connect 20,000 volts across the bottle. If the current jumps it, the whiskey is poor. If the current causes a precipitation of lye, tin, arsenic and slag, the whiskey is only fair. But if the liquor chases the current back into the generator, you're drinking real honest-to-goodness hooch!!

△ The introduction of the motorized cart took the walking out of golf. Now, thanks to two Florida inventors who have marketed a magnetized metal tee which clings to the club head, there is going to be golf without stooping.

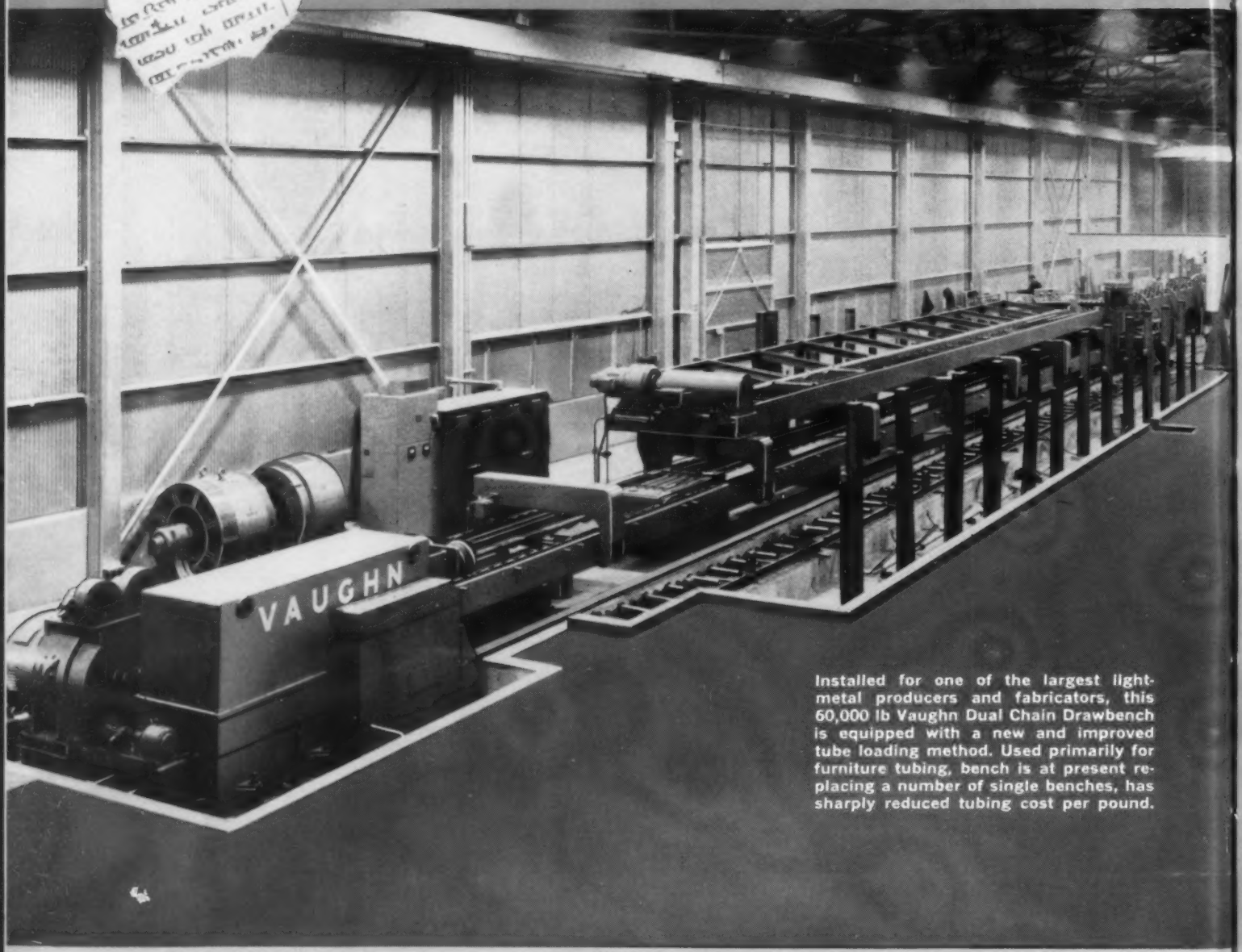
Now if somebody will come up with something to give us golf without swearing we can give up the game altogether.

△ The aggregate payroll for hourly and salaried employees in the iron and steel industry during the first five months of 1960, was a record $1,879,760,956. That total was some $29,000,000 higher than in the comparable part of last year when the figure was $1,850,755,999. Aggregate payroll for hourly and salaried workers was $339,780,711 in May, 1960, against $357,178,867 in April, 1960, and $396,914,755 in May, 1959.

Payroll cost per hour worked by hourly employees was $3.353 in May, 1960, against $3.381 in April, 1960, and $3.346 in May, 1959. In addition to payroll costs, it is estimated that employee benefits (pensions, insurance, supplemental unemployment benefits, and legally required payroll taxes) will cost the companies about $0.45 per hour on the average during 1960 making total employment costs per hour $3.803 in May, 1960.

# In the NEWS

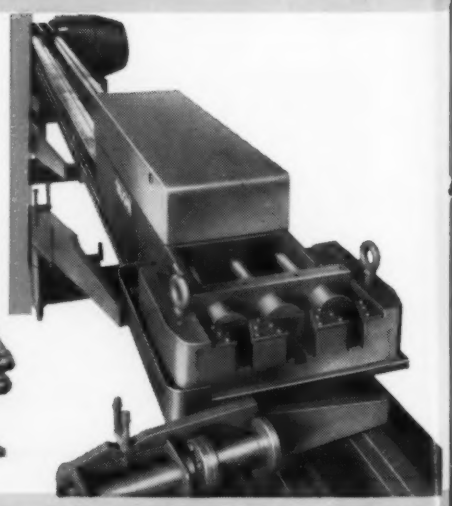
# Vaughn®




**Installed for one of the largest light-metal producers and fabricators, this 60,000 lb Vaughn Dual Chain Drawbench is equipped with a new and improved tube loading method. Used primarily for furniture tubing, bench is at present replacing a number of single benches, has sharply reduced tubing cost per pound.**

**This Vaughn Bench pulls 60,000 pounds for an Illinois steel and wire producer. Bench points and draws three — 1¼" bars simultaneously.**

**Air-operated carriage and skid arm, equipped with push-off, on Bench shown at left. Carriage has shock absorbers for each bar operating independently.**



# Drawbenches

## • NEW DESIGNS • HIGHER SPEEDS

## • Finer Cold Drawn Production!

Vaughn Machinery Company—builders of the world's most complete line of cold drawing equipment—is proud to present advanced new Drawbench models for tubes, bars, and shapes.

Available in double and single chain types, these latest Vaughn Benches employ totally new loading concepts that permit drawing five tubes at a time *and more.*

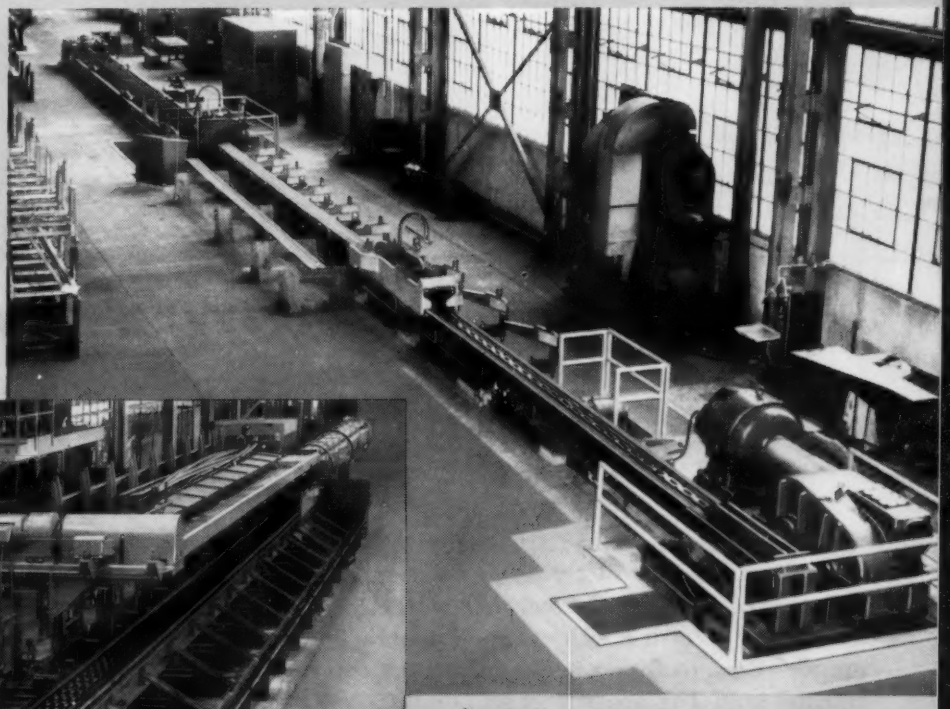
Vaughn dual chain benches now in operation are drawing tubing up to 550 fpm—straighter tubing! In fact, generally higher speeds are now feasible with a new chain design which permits high speeds without lubrication problems.

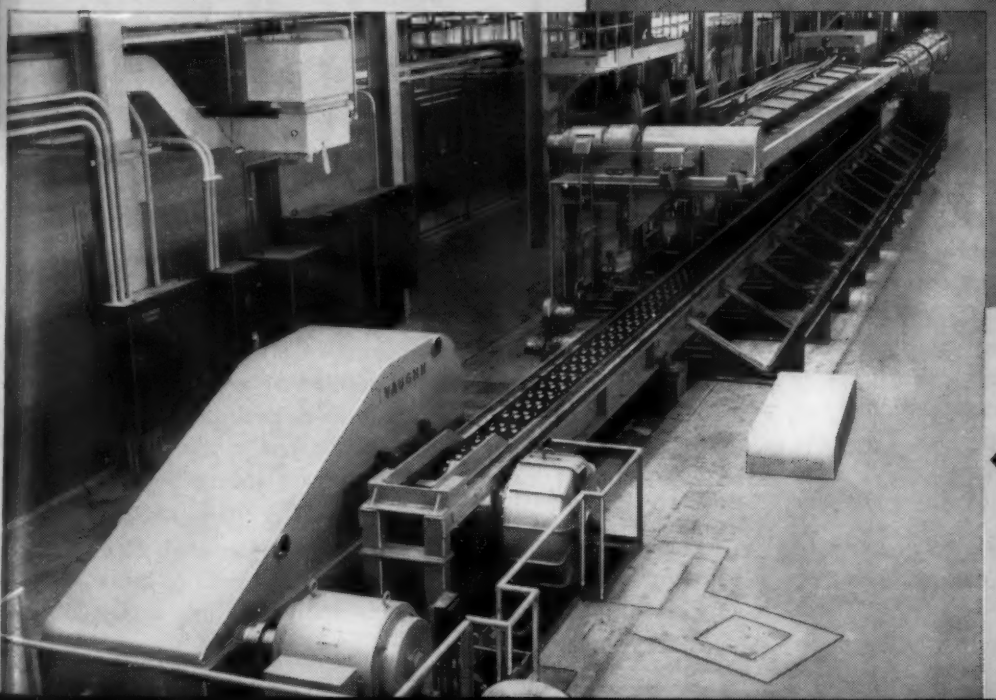
New "floating" foundation design reduces installation and foundation maintenance costs. Many additional refinements contribute to Vaughn leadership in modern drawbench performance. Consult your Vaughn engineer on your cold drawing problems.

**The Vaughn Machinery Company, Cuyahoga Falls, Ohio, U.S.A.**

*If it's Cold Drawn see* **Vaughn**

**COMPLETE COLD DRAWING EQUIPMENT—Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys.**



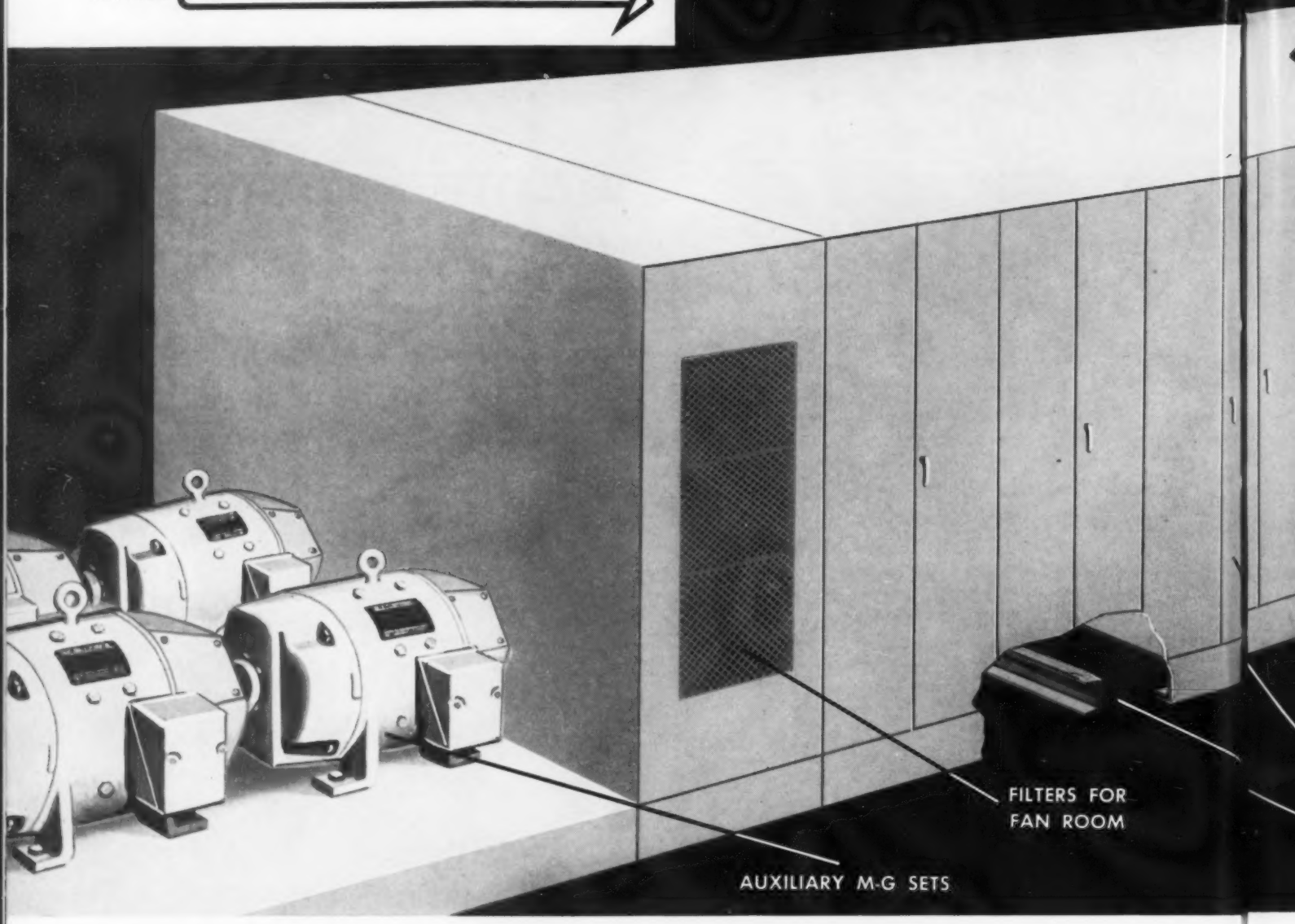



**For another Illinois producer, this Vaughn Drawbench is equipped for bars, tubes and shapes. It is used primarily for shaving magnesium on a production basis.**

**Installed at a large Canadian tubing producer, this Vaughn Drawbench includes roll-over mandrel end, carriage tube shock unit and air clutch. Canada's largest-ever order for copper tubing was recently drawn by this bench.**

FOR QUALITY... PRODUCTIVITY ... PROFIT

**METAL ROLLING**
**AUTOMATED BY GENERAL ELECTRIC**




## *A NEW PRACTICE IN PROCESS-LINE CONTROL*

# G-E "packaged" motor-control rooms reduce

The latest innovation in modern steel-mill process-line control is General Electric's new "packaged" motor-and-control room. This novel design, developed jointly by General Electric and Jones and Laughlin Steel Corp., groups all controls and m-g sets into one compact centralized unit. The above unit will be installed at J&L's Aliquippa, Pa., works, as part of their continuing facilities-improvement program. Previously, the installation expense on this equipment often matched or exceeded the actual cost of the equipment. The new G-E motor-control room design cuts installation costs as much as 40 percent!

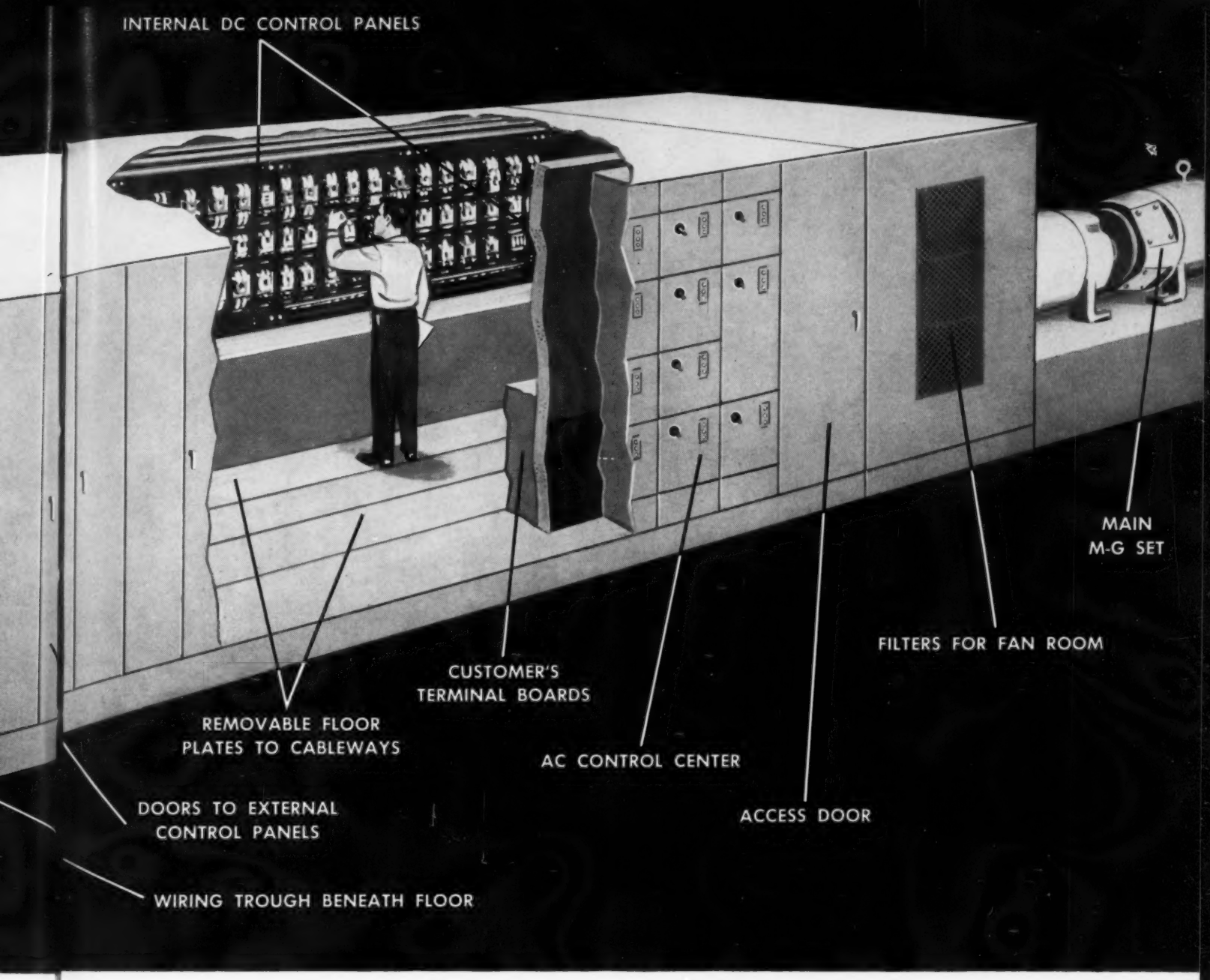
### HERE'S WHY INSTALLATION COSTS ARE LOWER

Substantial savings on installation expenses can be realized through these features:

**Independent control unit**—The General Electric motor-control room is a completely co-ordinated, pre-assembled unit in itself, and in many cases, eliminates the need for a separate motor room. Since the motor-control room is self-contained, it may be located either near the driven equipment or in some previously unused area of the mill.

**Field wiring is reduced by one-third or more**—All internal connections are made and tested before the motor-control rooms are shipped. The only field wiring required is the connection of the power source and the leads to the operators' stations and the drive motors.

**Construction engineering costs reduced**—General Electric's grouped control concept enables the mill to know its conduit requirements much sooner. Thus, fewer,




# installation costs as much as 40 percent!

less-complex construction diagrams are needed, and actual construction can begin at an earlier date.

**Common base minimizes installation time**—This new "packaged" motor-control room, delivered on its own self-supporting platform, can be immediately set on a normal mill floor. It does not require expensive, specially-constructed foundations. With m-g sets built and shipped on a common base, the need to align them at the mill site is eliminated. In addition, regulating equipment is factory-tested prior to shipment, further expediting startup time.

For all the details on this new technique in process-line control, contact your G-E Sales Engineer today! General Electric Company, Industry Control Department, Salem, Virginia, and Direct Current Motor and Generator Department, Erie, Pennsylvania. 785-7

*Progress Is Our Most Important Product*

GENERAL ELECTRIC

*Another example of National Roll quality control*

John Patton, National's assistant sales manager and Joe Marsalka, metallurgist, look over the reflectoscope "profile" of a steel roll.

# No flaw escapes this electronic eye!

Your steel rolls from National are given a thorough examination by reflectoscope before shipment. Ultra-high frequency sound waves traverse every segment of the roll, electronically assuring the absence of internal flaws which might shorten the roll's service life in your stand.

This attention to detail and emphasis on high quality of product are two reasons why more and more steel makers are turning to National for their steel, iron and nodular iron rolls. From the moment you call a National representative, your roll problem gets the *personalized* attention of men experienced in analysis, design and production.

We'd like to tell you more about how National Roll's expanded staff and facilities can serve you. Next best thing to a visit with us is a look at our new brochure. May we send you a copy? It helps explain why . . .

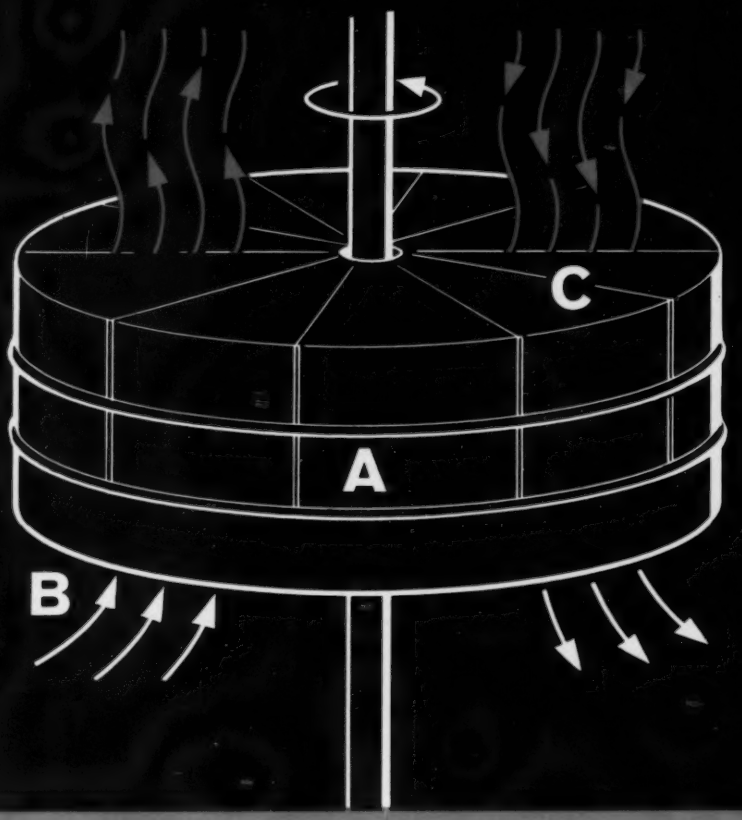
*National's the growing name in rolls*

## NATIONAL ROLL & FOUNDRY DIVISION

**GENERAL STEEL CASTINGS CORPORATION,** Avonmore (Westmoreland County), Pa.

General Steel Castings Corporation, General Offices: Granite City, Illinois • Plants: Granite City, Ill., Eddystone, Pa., Avonmore, Pa.

# COMPACT ROTARY HEAT EXCHANGER NOW AVAILABLE FOR STEEL INDUSTRY




Rotary regeneration makes the Ljungstrom more efficient than any other heat exchanger because the heat is absorbed by, and released from, **the same metal surface.** Heat recovery is continuous and uniform. All the heat exchange elements are contained in the rotor (A). Exhaust gases (B), diluted with air if necessary, pass through half the rotor and heat the elements. As the rotor revolves, these heated elements pass through the counterflow incoming air at (C). The incoming air absorbs the heat and carries it back to the combustion chamber. The Ljungstrom can be adapted to either horizontal or vertical flows of gas.

## Example: Can preheat air from 70° F to 1380° F

The Ljungstrom® Air Preheater is the most efficient metallic heat exchanger ever developed. It's the only heat exchanger *of any type* that, with an exhaust temperature of 1500°F, can raise incoming air from 70°F to 1380°F—and do it in so little space. A Ljungstrom measuring about 5′ x 7′ x 8′ can handle a furnace exhausting 30 x $10^6$ Btu/hr.

It's the continuous rotary regenerative principle that makes the Ljungstrom so efficient and so compact. Essentially, this rotary principle (explained more fully in the diagram above) permits the accumulation and release of heat by the same surface, thus reducing the surface required to recover a given amount of heat.

Another Ljungstrom characteristic is absolutely uniform air preheating. The slowly revolving Ljungstrom rotor heats incoming air continuously, so you get a *steady high temperature* instead of fluctuations typical of cycling checkers. And because of the depth of the heating elements—two to three feet—the heating surfaces can be readily cleaned to maintain continuous maximum recovery.

Ljungstroms have been used with many types of fuel, including crude and refinery oils, coke-oven gas, natural gas and blast furnace gas. Applications include industrial and utility boilers, high temperature refinery stills, and special industrial processes of many types.

Present high-temperature designs accommodate exhaust gases to 1500°F, and Air Preheater is developing and testing designs for temperatures well above 2000°F. The Ljungstrom Air Preheater has many potential steel mill applications: soaking pits, slab, billet and skelp heating furnaces, etc. For further information on the Ljungstrom Air Preheater and its possibilities for heat recovery in steel mills, phone or write to:

**THE AIR PREHEATER CORPORATION**

*60 East 42nd Street, New York 17, N. Y.*
MUrray Hill 2-8250

# Pick-up for Productivity...

## Install
# WAGNER *POWERED*
## hydraulic brakes on busy cranes

Are shuddering, crane-wrenching stops . . . skid-by-the-spot stops . . . premature stops . . . reducing the productivity of your operation? Put an end to them. Equip your busy cranes with Wagner *Powered* Hydraulic Crane Bridge Brakes.

Wagner *Powered* Braking Systems reduce wear on equipment. Smooth power operation ends bridge motor plugging with its resultant damage to both motors and gears. Brakes don't drag and unnecessarily wear wheels and linings. You get safer, more efficient crane operation. Operators can stop cranes consistently and smoothly . . . productivity is increased, particularly in operations where frequent starts and stops are necessary, where close spotting is required, where heavy equipment is involved.

Your operators perform more efficiently, too, because there's far less fatigue. They can stop cranes with an easy touch of toe on a button while the heel rests comfortably on the floor. Several brakes can be operated from one station.

These power units can be added to your present Wagner Hydraulic System. Let your nearby Wagner Industrial Brake Application Engineer show you how easy, fast and economical such an installation can be. There are Wagner branches in 32 principal cities.

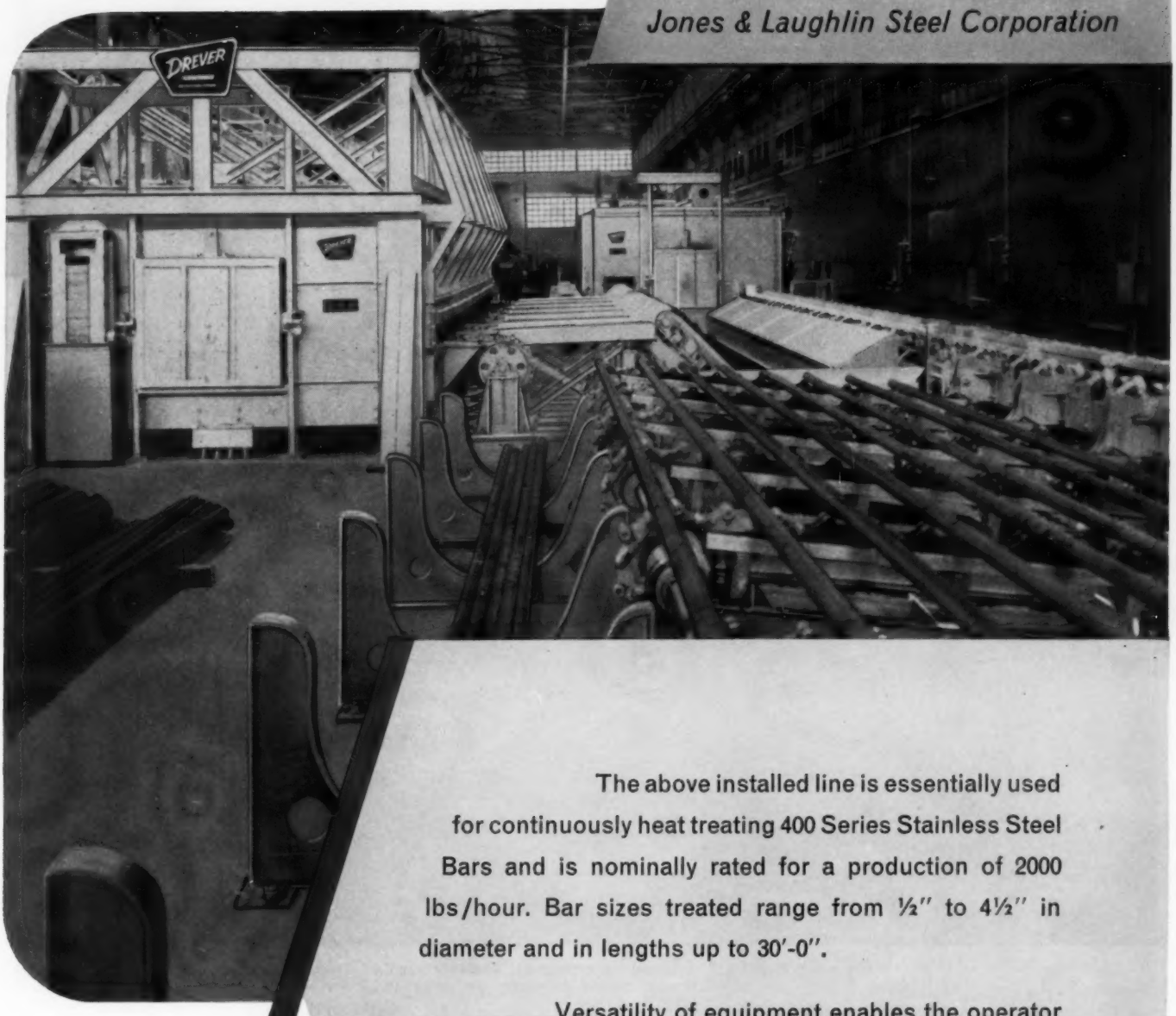
**Wagner Electric Corporation**
6483 Plymouth Ave., St. Louis 33, Missouri

SERVING 2 GREAT GROWTH INDUSTRIES—*ELECTRICAL • AUTOMOTIVE*

# DREVER

## *Continuous* BAR HEATING LINE

*at the Detroit Plant of the Stainless and Strip Division of Jones & Laughlin Steel Corporation*




The above installed line is essentially used for continuously heat treating 400 Series Stainless Steel Bars and is nominally rated for a production of 2000 lbs/hour. Bar sizes treated range from ½" to 4½" in diameter and in lengths up to 30'-0".

Versatility of equipment enables the operator to automatically change from a normalizing cycle to a heat treat cycle, including quench and draw facilities, without the interruption of the continuous operation.

We welcome your inquiry on your wire, rod, bar, sheet, plate and strip heating problems.

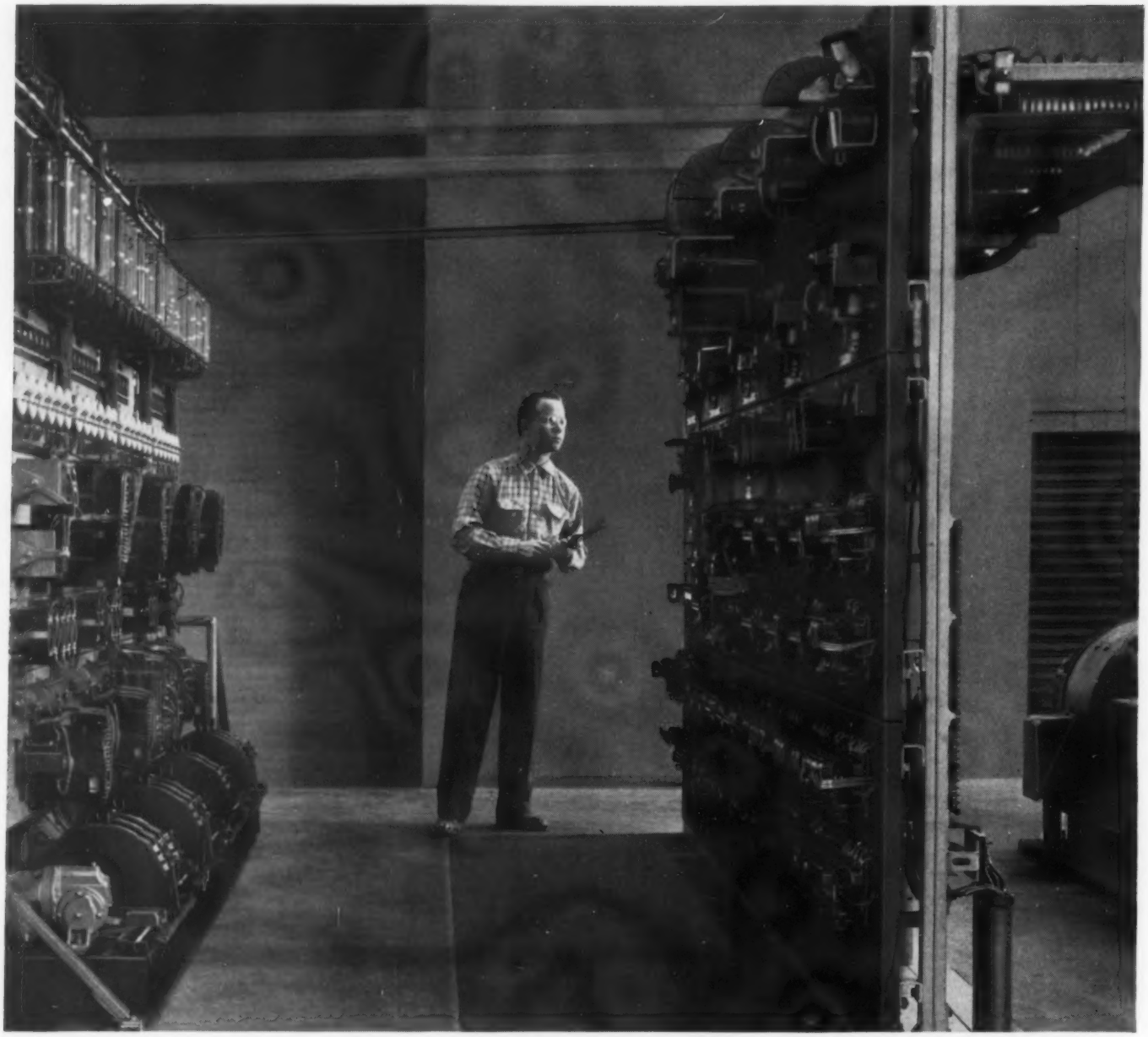
DREVER COMPANY

Red Lion Rd. & Philmont Ave.
*BETHAYRES, PA.*

40

Engineering and Manufacturing Facilities Around the World through Associates in France, Great Britain, Germany, Italy and Japan

# ALLIS-CHALMERS



Allis-Chalmers magnetic-amplifier regulators on a single-stand mill provide accurate tension control necessary for rolling .00035-inch foil (doubled) at 3000 fpm.

## Precision control installation engineered by Allis-Chalmers ran

# production foil the first day

**Control systems** for high-speed foil rolling applications require a high degree of engineering knowledge and skill. Allis-Chalmers coordination of design, manufacturing and installation is clearly demonstrated by results like quality production of thinner-than-paper foil on the first day of operation.

Allis-Chalmers builds control for every rolling operation . . . from the largest main mill to the smallest finishing mill.

Allis-Chalmers first developed heavy-duty control for large tandem mill drives. Now A-C applies these same high-accuracy, high-quality standards to the design and performance of control equipment for smaller installations such as single-stand foil finishing mills.

The result — regulating systems of extremely high precision . . . reliability under the most demanding production schedules.

*Specify Allis-Chalmers electrical equipment on your next mill installation. Call your nearby A-C sales office or write:* **Allis-Chalmers,** *Industrial Equipment Division, Milwaukee 1, Wisconsin.*

A-1281

# patent reviews

By MELVIN NORD, Patent Attorney, Detroit, Mich.

*Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents . . . patents reviewed cover period February 9, 1960 to March 1, 1960*

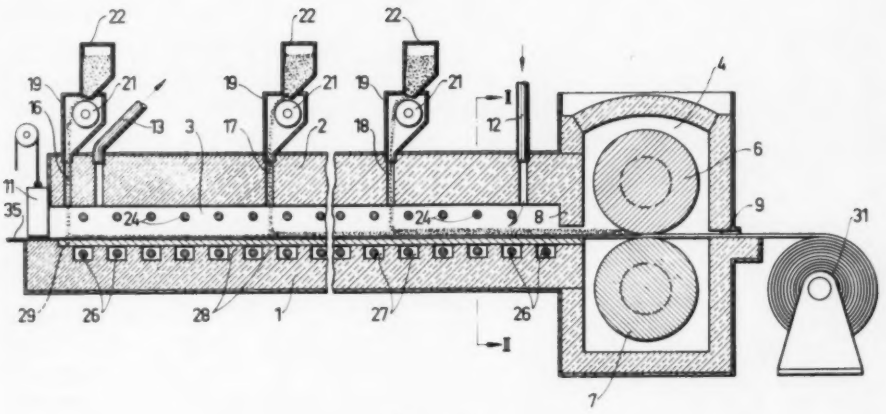


Figure 1

### PRODUCTION OF ROLLED STEEL PRODUCTS FROM FINE GRAINED IRON MATERIAL

△ U. S. 2,925,337 issued Feb. 16, 1960, to Bo Michael Sture Kalling, Sven G. H. Eketorp and Folke K. E. Johansson, assigned to Stora Kopparsberg Bergslags Aktiebolag, describes a method of producing rolled steel products from pig iron in fine-grained powder form.

As shown in Figure 1, an iron plate 35 with a thickness of about 1 mm is passed through the inlet end of the heated oven, after having been provided with somewhat turned up edges. As the plate 35 runs forward through the oven channel, it is sprinkled with pig iron powder mixed with the necessary quantity of iron oxides, for instance, in the form of highly concentrated dressed iron ore, from the slits 16, 17 and 18, which should be so positioned that the powder will be sufficiently heated, for instance, to 1100 C that the reaction at least partly takes place before it reaches the next filling slit. The plate band 35 will finally reach the closed chamber 4 where the now more or less sintered powder will be compressed by the cylinders 6 and 7 to a compact body welded to the plate 35 into a unitary body which is discharged through the opening 9 and if adequately thin, may be wound in a winder 31. From the winder the material is brought to some other place for final rolling in heated or cold condition, if desired, in combination with an annealing treatment.

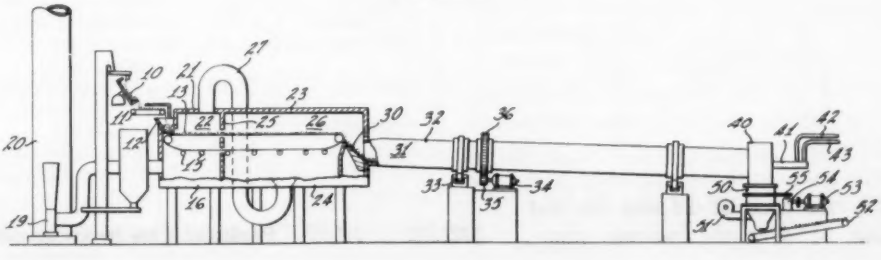
### PRODUCTION OF HARD BURNED AGGLOMERATES

△ U. S. 2,925,336, issued Feb. 16, 1960, to William F. Stowasser, Jr., and assigned to Allis-Chalmers Mfg. Co., provides a process for making hardened pellets of iron ore from finely divided iron oxide ores and concentrates such as magnetite produced from taconites.

The process is carried out in the apparatus shown in Figure 2, by placing the green water bound pellets on the grate 13. It has been found that a layer of about seven in. deep will give good results with green pellets averaging in size between one-half and three-quarters of an inch in diameter. The body of pellets established on the grate 13 is then passed through the first zone 22 and then through the second zone 26 and discharged into the third zone 31 established within the rotary kiln 32. The pellets are then tumbled through the third zone 31 in the kiln 32 and discharged into the cooler 50.

A flow of highly heated strongly oxidizing gases is effected that is countercurrent to the movement of the pellets through the third zone 31. Fuel and primary combustion air delivered through the tubes 42, 43 connected to the burner will provide a flame extending into the rotary kiln. The quantity of air supplied by the secondary blower 51 for countercurrent flow through the

Figure 2



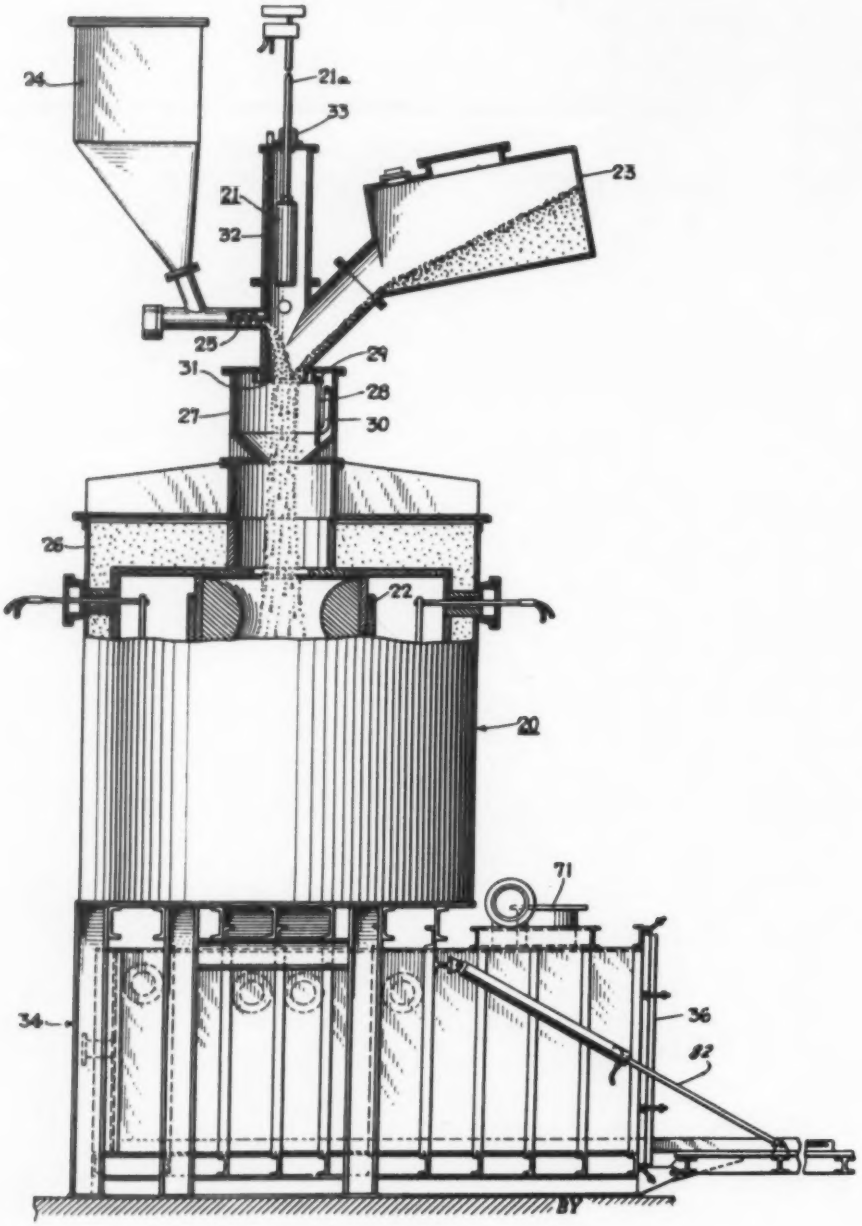



Figure 3

pellets in the cooler 50 will insure a sufficient excess of air being admitted to the rotary cooler to provide strongly oxidizing heated gases. The highly heated oxidizing gases, after they have passed through the third zone 31 in the rotary kiln 32 countercurrent to the flow of tumbling pellets within the kiln, are delivered to the interior of the hood 23 defining the second zone 26 over the pellets on the moving grate. The exhaust fan 19 associated with the stack 20 will draw the heated oxidizing gases from the second zone 26 above the moving grate 13 through the pellets on the moving grate and into the second wind box 24 below the grate and then through the tube 27 to the hood 21 defining the first zone 22 over the moving grate. From the first zone 22 the gases will be drawn downwardly through the pellets on the grate into the first wind box 16 beneath the first zone from where the gases will pass to the atmosphere up through the stack 20.

### APPARATUS FOR PRESSING CONSUMABLE ELECTRODE BILLETS

△ U. S. 2,925,619, issued Feb. 23, 1960, to Thomas A. Sindelar, assigned to Republic Steel Corp., provides apparatus for pressing consumable electrode billets for use in electric furnaces where such billets are melted to form ingots.

The invention is particularly concerned with metals which may be melted only with great difficulty, such as titanium or zirconium.

### SKULL TYPE FURNACE

△ U. S. 2,925,636, issued Feb. 23, 1960, to Paul F. Darby and assigned to Crucible Steel Co. of America, provides a skull type furnace for the melting and casting of refractory materials which, in the molten state, show high chemical reactivity, such as, for example, titanium or zirconium.

The furnace, which is shown in Figure 3, is constructed in substantially all of its parts, except the outer metal housing, of graphite slabs, planks, supports and bricks.

### APPARATUS FOR SPREADING A MOVING WEB

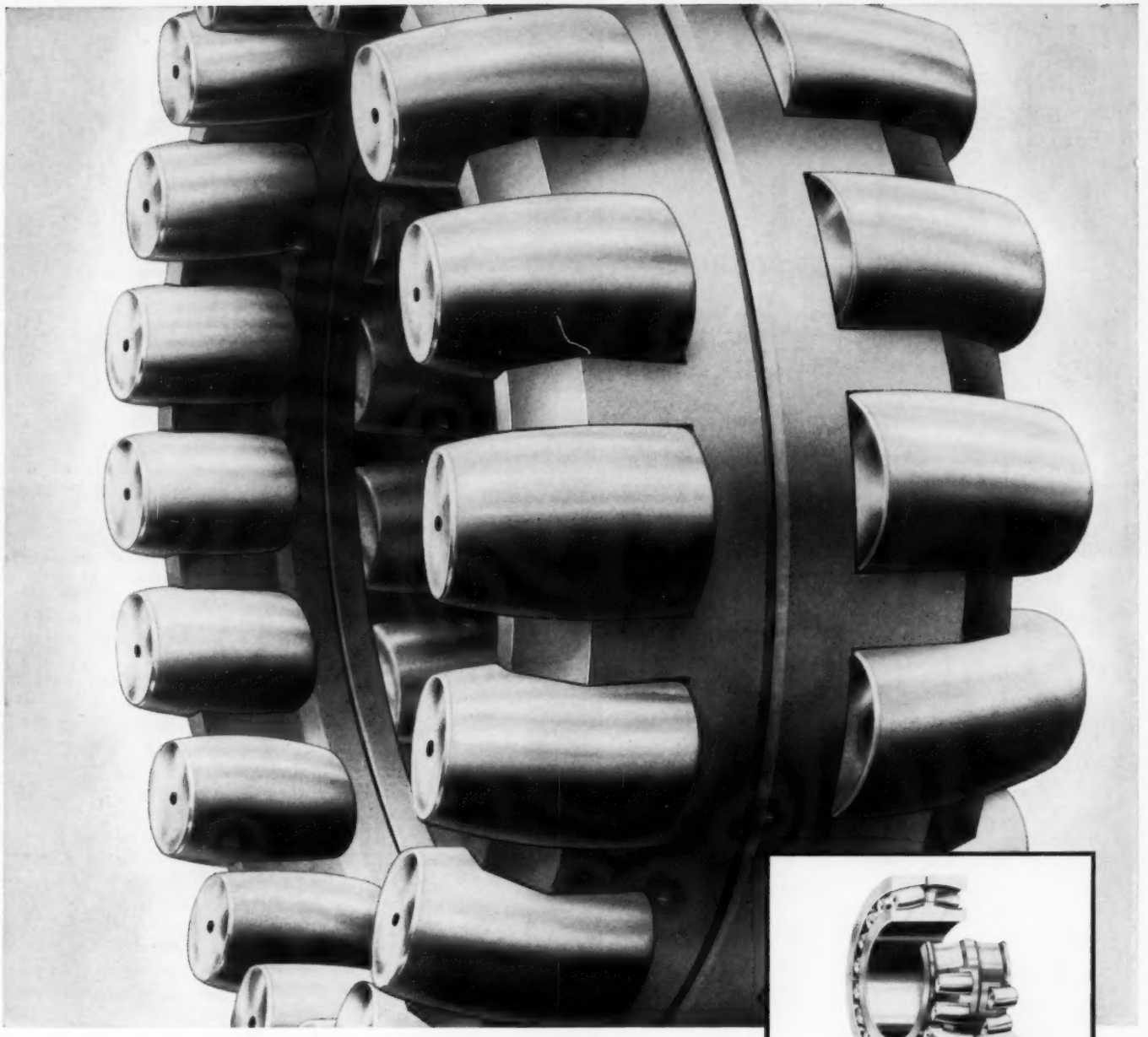
△ U. S. 2,925,640, issued Feb. 23, 1960, to Harry C. Morrow, assigned to United States Steel Corp., provides apparatus for spreading a moving web or strip made of textiles, plastic, or paper.

### PRODUCTION OF IRON POWDER FROM FERROUS SULPHATE

△ U. S. 2,927,016, issued March 1,

**OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER**

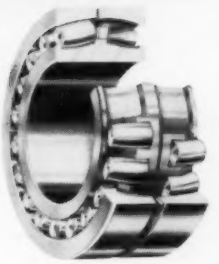
| Patent No. | Date | Subject | Inventor or assignee |
|---|---|---|---|
| 2,923,946 | 2/9/60 | Safety mitten | United States Steel Corp. |
| 2,923,965 | 2/9/60 | Pelletizing apparatus | Jones & Laughlin Steel Corp. |
| 2,924,136 | 2/9/60 | Flying shear | Birdsboro Steel Foundry & Machine Co. |
| 2,924,230 | 2/9/60 | Machine for continuous hardening | Heurtey & Cie |
| 2,924,269 | 2/9/60 | Blast furnace stove gas-port and burner nozzle connection | United States Steel Corp. |
| 2,924,492 | 2/9/60 | Pivoted anti-friction bearing | United States Steel Corp. |
| 2,924,543-4 | 2/9/60 | Cold-finished steels | LaSalle Steel Co. |
| 2,925,168 | 2/16/60 | Apparatus for improving trucking of endless belts | United States Steel Corp. |
| 2,925,610 | 2/23/60 | Hot forging machine having stock descaling means | The National Machinery Co. |
| 2,925,637 | 2/23/60 | Hot top lining | Foundry Services, Ltd. |
| 2,926,103 | 2/23/60 | Aluminum cladding of steel strip | Continental Can Co., Inc. |
| 2,926,903 | 3/1/60 | Bustle pipe for blast furnaces | Strico Gesellschaft fur Metallurgie und Warmetechnik m. b. H. |
| 2,927,015 | 3/1/60 | Production of low density iron powder | The S. K. Wellman Co. |



# "Caged" for Longer Life!

The two land-riding cages in Torrington Spherical Roller Bearings assure proper roller spacing and guidance, even under rugged conditions of shock load and sustained high speeds. These fully machined cast bronze cages operate independently. Their design eliminates drag on rollers. These high-strength cages help bearings give longer life by providing low friction, smooth running and cool operation. Highly effective and generous lubrication of all contact surfaces is achieved with the open-end cage design.

The result: Torrington Spherical Roller Bearings are built to give extra years of unmatched service life in heavy-duty applications. Torrington's long experience in design, engineering and manufacture of every basic type of anti-friction bearing provides the finest spherical roller bearings available. You'll find it pays to standardize on Torrington.



**Superior design features of TORRINGTON SPHERICAL ROLLER BEARINGS**

- integral guide flange for roller stability
- asymmetrical rollers seek flange for positive guidance
- electronically matched rollers
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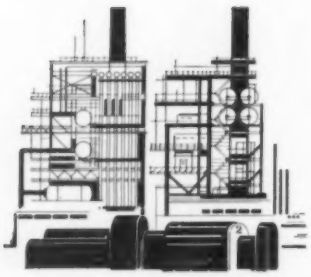
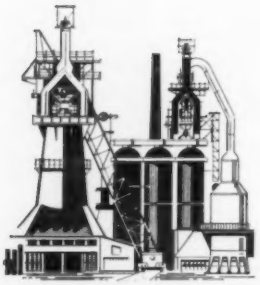
- fully machined land-riding bronze cages
- controlled internal clearances
- even load distribution
- inherent self-alignment
- long service life

*progress through precision* **TORRINGTON BEARINGS**

**THE TORRINGTON COMPANY** South Bend 21, Indiana • Torrington, Conn.

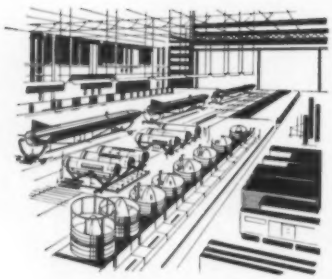


ELECTRIC POWER

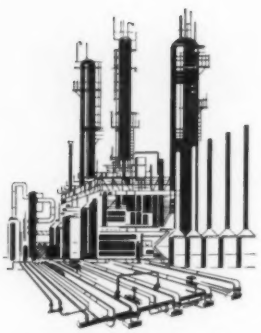


STEELMAKING

**RW-300**



MISSILE AND AIRCRAFT



OIL REFINING AND CHEMICAL

# MANY "LEADERS" IN DIGITAL COMPUTERS, BUT ONLY ONE LEADER IN DIGITAL CONTROL COMPUTERS

**THE THOMPSON-RAMO-WOOLDRIDGE PRODUCTS COMPANY**

a division of ***Thompson Ramo Wooldridge Inc.***

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# 80% OF ALL DIGITAL CONTROL COMPUTERS NOW OPERATING IN INDUSTRY ARE RW-300 SYSTEMS

There are many companies which make various kinds of digital computers. These electronic machines serve useful purposes, ranging from the handling of payrolls to the solving of abstract mathematical problems, but they are not intended to *control* industrial processes. They are not designed to be connected directly to processes or test loops.

The Thompson-Ramo-Wooldridge RW-300 Digital Control Computer is built specifically for that purpose—to operate continuously a diversity of production processes in such industries as electric power, primary metals, missile and aircraft, electronics, chemicals, petroleum refining, pipelines, cement, and nuclear.

The RW-300 leads the field with 18 installations which have logged a total of 145,000 hours of operation—more than 16 years. It provides reliability exceeding 99% in around-the-clock applications. That is why you will see RW-300 systems in 80% of all industrial installations employing digital control computers.

For further information on the RW-300 and the associated engineering services, call or write Mr. Raymond E. Jacobson, Director of Marketing, Dept. ISE-1218-1.

*RW-300 computer controlling ammonia production at Monsanto Chemical Company plant, Luling, Louisiana.*

TRW


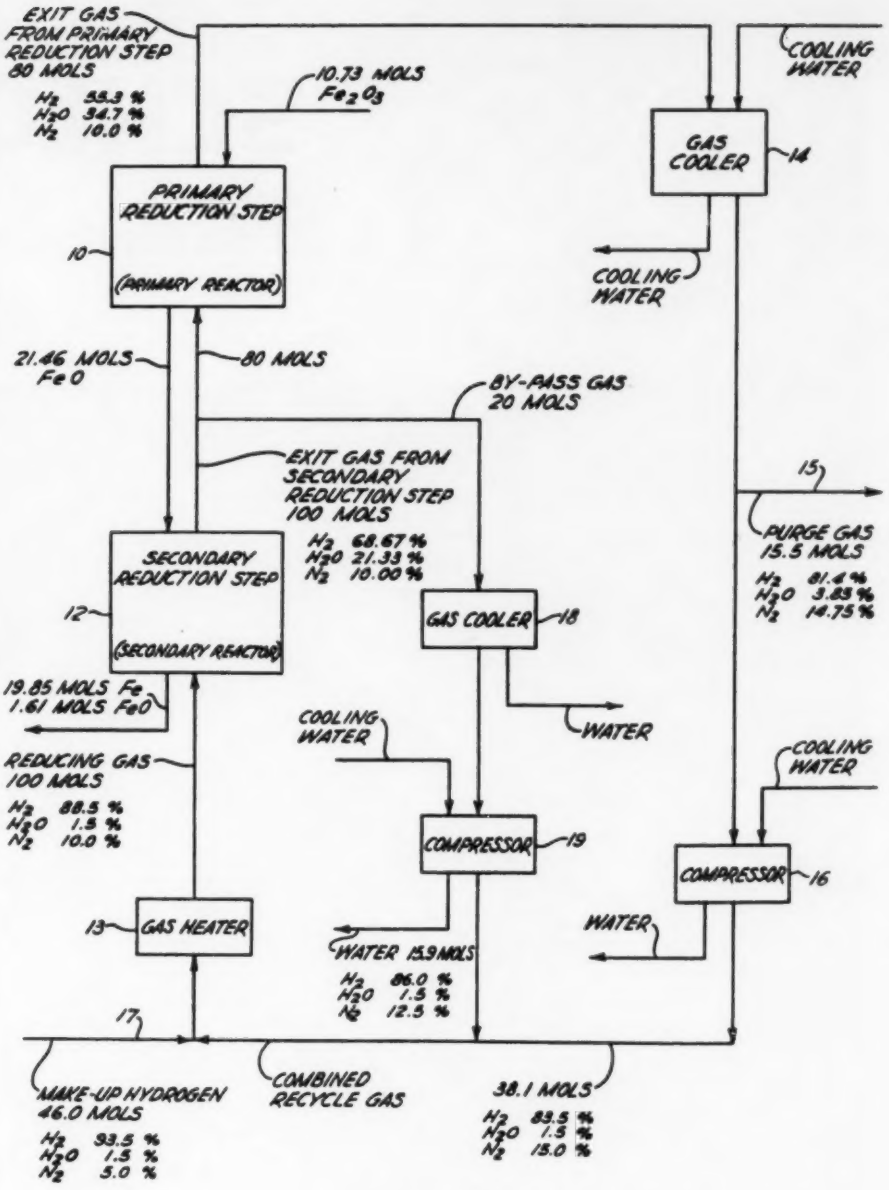


**Figure 4**

1960, to Charles B. Francis and assigned to Puriron & Chemicals, Inc., describes a process for the production of iron powder from the ferrous sulphate obtained from spent sulphuric acid used in pickling.

The process starts with "sugar sulphate" obtained from pickle liquor by evaporation and crystallization. The sugar sulphate contains about 79.5 per cent $FeSO_4$, 20 per cent water and 0.5 per cent impurities. The sugar sulphate is first dehydrated and pulverized at 300 to 340 F. The dry salt is then decomposed at 1100 to 1400 F in the presence of air to burn out the contaminating organic matter and to form $Fe_2O_3$ and $SO_2$.

The $SO_2$ may be treated to produce sulphuric acid or it may be combined with a base.

The $Fe_2O_3$ is reduced with hydrogen at 700 to 900 F. The pyrophoric iron powder thus formed is cooled in an atmosphere of dydrogen, to 100 F, and delivered to a closed container.

### FLUIDIZED-BED REDUCTION OF ORE

△ U. S. 2,921,848, issued Jan. 19, 1960, to Jagdish C. Agarwal and assigned to United States Steel Corp., describes a method for continuous direct reduction of iron oxide in a two-step fluidized bed system.

The exit velocity from the primary step is lowered to match that from the secondary, thus increasing efficiency and reducing dust loading.

The process is illustrated diagrammatically in Figure 4.

# SCHLOEMANN

## 21 Aluminum Cable Sheathing Presses in three Years

**Operational sequence of the SCHLOEMANN aluminum cable sheathing press is now fully automatic, in continuous cycles. Sheathing thickness is held to specification even though extrusion may be interrupted. This press is an outstanding example of many successful innovations accomplished by SCHLOEMANN in connection with the plastic deformation of steel and non-ferrous metals.** *Write today for descriptive literature.*

**FELLER ENGINEERING COMPANY** 1161 Empire Building, Pittsburgh 22, Pa.

HOT AND COLD ROLLING MILLS • COUNTERBLOW HAMMERS • HYDRAULIC PRESSES

# How to starve a scrap pile* at its source

## * and all it represents

(DAMAGED TOOLS, RUINED MACHINES, REJECTS, WASTED LUBRICANTS, UNSCHEDULED DOWNTIME . . .)

TEXACO

# Start a "STOP LOSS" program

**Bearings ruined** before their time by improper lubrication
**Downtime** caused by a man with the wrong grease gun
**Lubricants** wasted by over-lubrication
**Damaged tools** — burned and cratered by using the wrong type of cutting oil
**Rejects** from faulty cutting and grinding

LUBRICATION IS A MAJOR FACTOR IN COST CONTROL

Texaco's "Stop Loss" program has been developed for progressive managers in production, maintenance, purchasing, engineering and accounting who wish to apply new methods to control costs and add to profits.

The program has two purposes: (1) to demonstrate how organization of lubrication practices can be used to control costs resulting from product rejects, downtime, machine repair, excessive inventory, and (2) to provide specific instruction material to help plant groups find out where and how they can use Organized Lubrication to control costs in their own operations.

Lubrication is common to almost all plant functions. So don't be surprised when the "Stop Loss" program reveals ways to save in many places!

TURN PAGE FOR WHY

# Expect tangible results!

## HERE'S WHY AND WHERE:

In 1959, hundreds of plants organized their lubrication practices to reduce costs.

Their managements had recognized this fact: *Lubrication is no longer just a routine operating procedure. It is a key factor in controlling costs and, as such, rightly becomes a management function.*

This doesn't mean that management must put on overalls and grab a grease gun. But when management recognizes the dollars-and-cents significance of Organized Lubrication, they have made the first step toward reduced costs throughout the plant.

The Texaco Organized Lubrication Plan studies your lubrication methods in terms of long-range savings in production, equipment life, manhour utilization and inventory. A re-evaluation in terms of Organized Lubrication usually reveals how immediate savings can be made and continued.

Texaco has developed techniques and experience to make this new concept operative. They are offered to you, with the understanding that any Organized Lubrication program depends for success on those who adopt it and apply it.

## Here's the help you need to starve YOUR scrap pile

Here are the parts of the Texaco Organized Lubrication Plan available to interested plant groups:

**1. "Stop Loss with Organized Lubrication,"** a new 25-minute color and sound film created to show the opportunities for cost control through "Organized Lubrication."

**2. A film "package" for plant departments.** This consists of movies on cutting oils, greases, hydraulic oils, etc., that may be selected for showing after seeing the "Stop Loss" film.

**3. Coordinated booklets** on the film subjects and others to be used as guides in specific areas.

**4. A Texaco Lubrication Control System** to take the guesswork out of your lubrication scheduling. This simple system costs almost nothing to install, yet can save up to 15 per cent of your maintenance costs.

We can promise you that a modern Texaco Organized Lubrication Program will produce a package of economies in your plant. Texaco Inc., 135 E. 42nd St., N. Y. 17, N. Y.

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# METALGRAMS

UNION CARBIDE METALS

. . . news of "Electromet" ferroalloys and metals

JULY 1960

NEW LOOK IN FERROALLOYS -- Steelmakers are using greater tonnages of the new forms in which certain alloys are supplied by Union Carbide Metals. For example, refined chrome and 75 per cent ferrosilicon are available as convenient pigs that greatly simplify handling. When added to the furnace or ladle, these pigs give higher metallic yield because no fines are lost in the slag. Their use? Refined chrome is used in stainless steel, aircraft and bearing steels, tool steels, and cast iron. 75 per cent ferrosilicon is a popular open-hearth ladle addition, particularly in electrical steels.

* * *

UNIT-WEIGHT PACKAGES GROW -- A popular packaging feature of many "Electromet" alloys is unit-weight cans and bags. Containing exact weights of alloying elements, these packages provide accurate alloy additions simply by counting out the number of packages required. "Chromtemp" exothermic ferrochrome and "Mantemp" exothermic ferromanganese -- highly efficient ladle addition alloys for open-hearth steels -- are packed in unit-weight cans. So are self-reducing tungsten and self-reducing vanadium, economical alloys for tool and constructional steels. Also, 17 "Electromet" alloys are available in unit-weight bags.

* * *

FORMS PROCESSED IN A VACUUM -- Other alloy forms include bricks and pellets of "Simplex" ferrochrome, a widely used low-carbon ferrochrome for stainless steel. These convenient forms are available because the alloy is vacuum-processed to drive carbon down to extremely low levels. Having the lowest carbon content of any ferrochrome available, the alloy aids stainless melters in meeting low-carbon specifications. Also, "Simplex" ferrochrome penetrates the slag and dissolves readily. As an aid to handling, storage, and inventorying, the bricks are packed in new pre-weighed steel-strapped bundles.

* * *

AT YOUR SERVICE -- Improved alloys and packaging techniques are under constant study at Union Carbide Metals. Experienced materials-handling representatives work directly with metal producers to help determine the most efficient and economical types of alloy packaging and handling in individual plants. Their recommendations on traffic, handling, storage, and usage often result in big savings in money, time, space, or material.

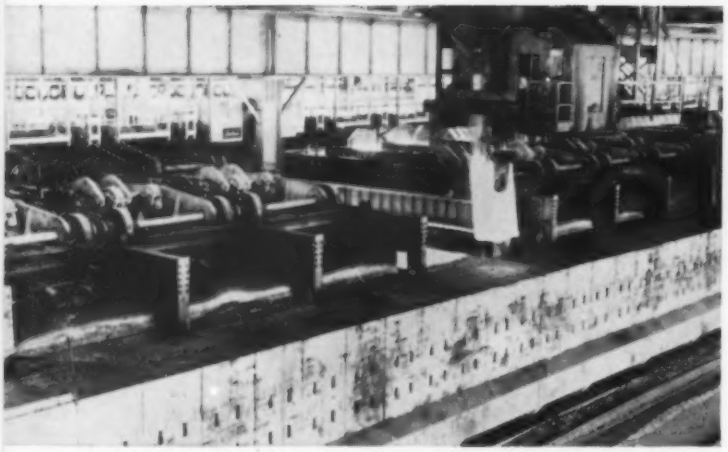
* * *

NATION-WIDE FACILITIES -- To meet the demand for a wide variety of alloys and metals, Union Carbide Metals maintains an efficient warehouse and distribution network to serve metal producers throughout the country. Stocks are maintained at 6 plants and 26 warehouses conveniently located near major metal-producing centers. Rail, truck, barge, and boat shipments speed products to customers' plants. Your Union Carbide Metals representative will be glad to give you further information about the products and services described above. Ask for the article, "Electromet Alloys...When, Where, How You Need Them," in the Winter 1959 issue of UNION CARBIDE METALS REVIEW.

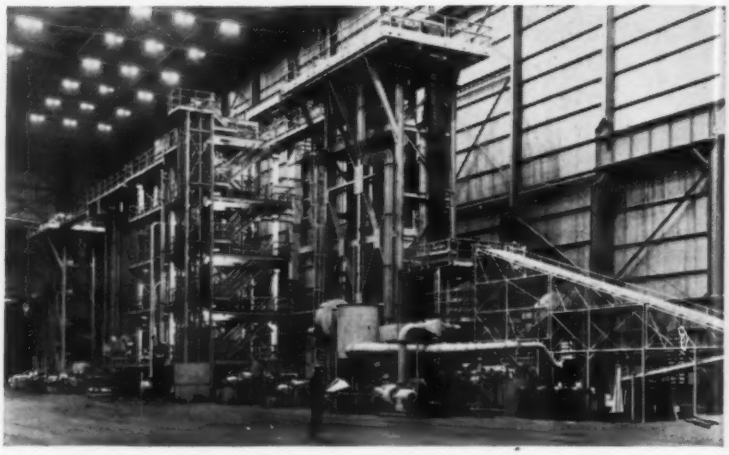
* * *

UNION CARBIDE METALS COMPANY, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. In Canada: Union Carbide Canada Limited, Toronto.

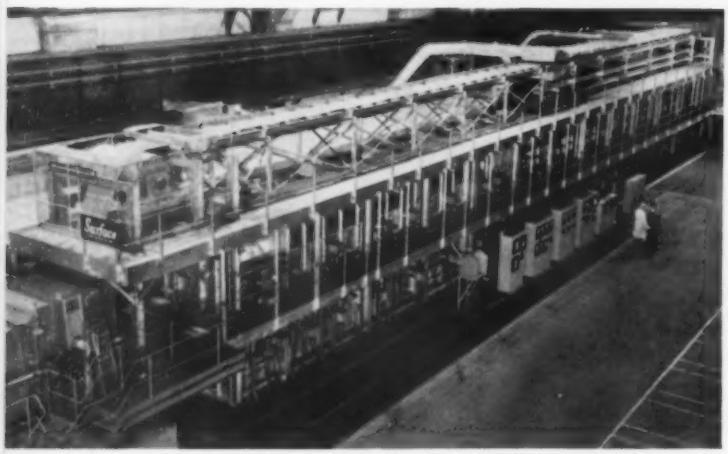
"Chromtemp," "Electromet," "Mantemp," "Simplex," and "Union Carbide" are registered trade marks of Union Carbide Corporation.



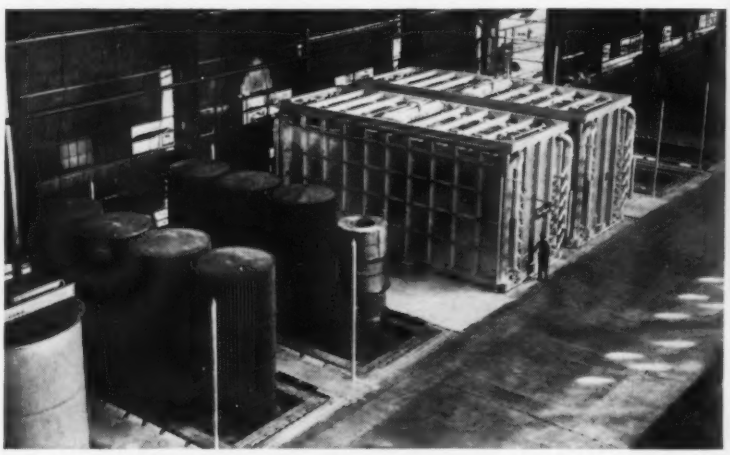
48 soaking pits installed at one time.



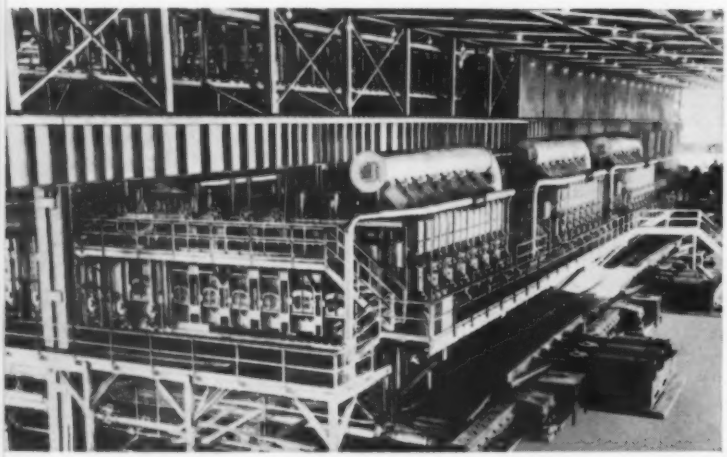
Continuous tin plate annealing line.



Normalizing line for enameling strip.



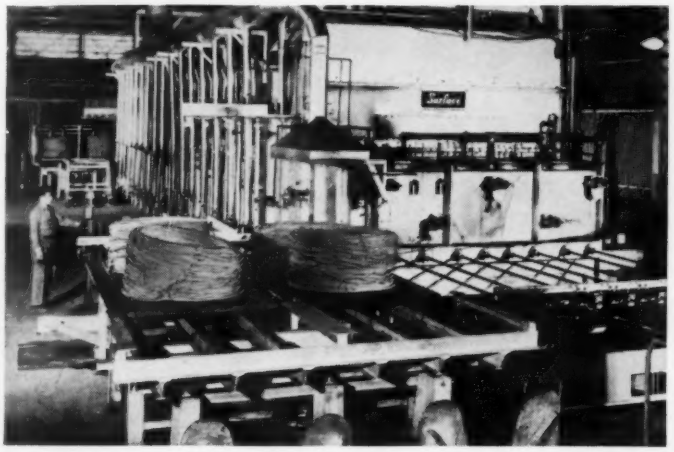
Multiple-stand annealing covers.



World's largest slab-heating furnaces.

Continuous strip galvanizing line.

Single-stand radiant tube annealers.



Annealing, carbon restoration furnace.

Car-bottom rod and bar furnace.

# PROVING GROUNDS

## for steel profits

Surface Combustion's proving grounds—a few of which are shown at the left—include virtually every rolling mill in North America plus a considerable number abroad.

You can sample here the variety of Surface equipment which has passed the toughest tests on the steel mill floor: checked out for quality, shaken down for reliability, and—most important to you—proved out for profitability.

With internal costs and external competition on the rise, it will pay you more than ever before to specify the services and equipment of a company which has repeatedly passed the tests in steelmaking's ultimate proving grounds. Surface Combustion, 2404 Dorr Street, Toledo 1, Ohio.

A division of Midland-Ross Corporation

Surface

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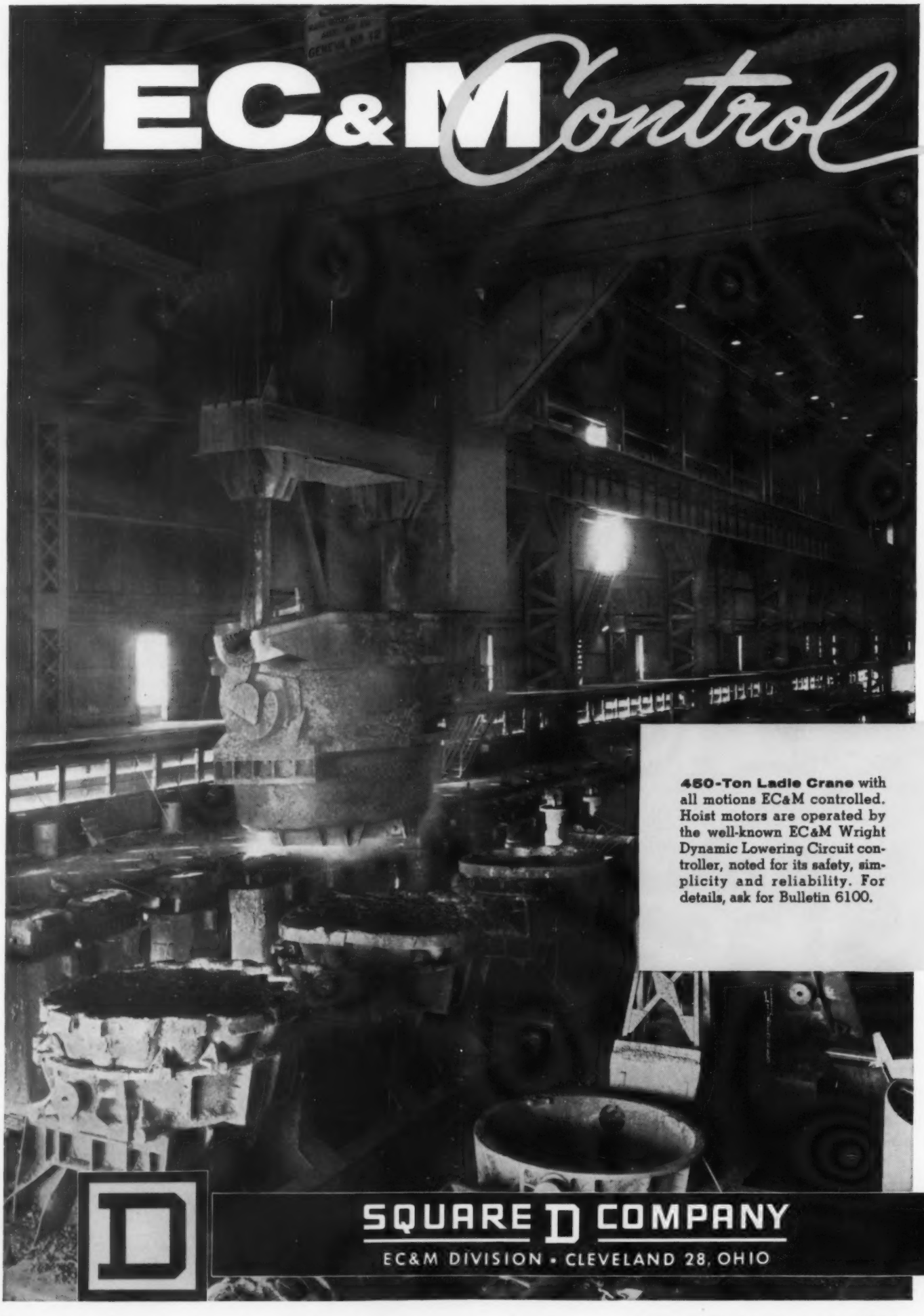
# EC&M Control



**450-Ton Ladle Crane** with all motions EC&M controlled. Hoist motors are operated by the well-known EC&M Wright Dynamic Lowering Circuit controller, noted for its safety, simplicity and reliability. For details, ask for Bulletin 6100.

SQUARE D COMPANY

EC&M DIVISION • CLEVELAND 28, OHIO

# tames the giants at Columbia-Geneva!

KEEPING A TIGHT REIN on the toughest and most exacting operations at the Columbia-Geneva Works of United States Steel Corporation is the responsibility of EC&M control. Here, at Geneva, as well as throughout the metal-producing industry, EC&M control apparatus and engineering have earned a reputation for safe, reliable performance in basic steel making.

EC&M control is built to meet the rigid demands of open hearth and rolling mill departments. For cranes, charging machines and mill auxiliary drives, EC&M control equipment is unexcelled.

**Operator's pulpit,** overlooking the 132″ reversing-rougher, contains EC&M Slider-Contact panels for automatic-positioning of horizontal and vertical rolls. Slider-Contacts may be moved up or down to change to new rolling schedules or to make minor adjustments quickly when rolls are changed. Roller operates a single push button to produce products rolled to accurate tolerances. For complete facts, write for Bulletin 6550.

**EC&M 65-inch Type SW all-welded lifting magnet** on overhead crane successfully withstands wide temperature changes in handling crop-ends from cooling pits. Bulletin 1300 describes EC&M lifting magnets for steel mill service.

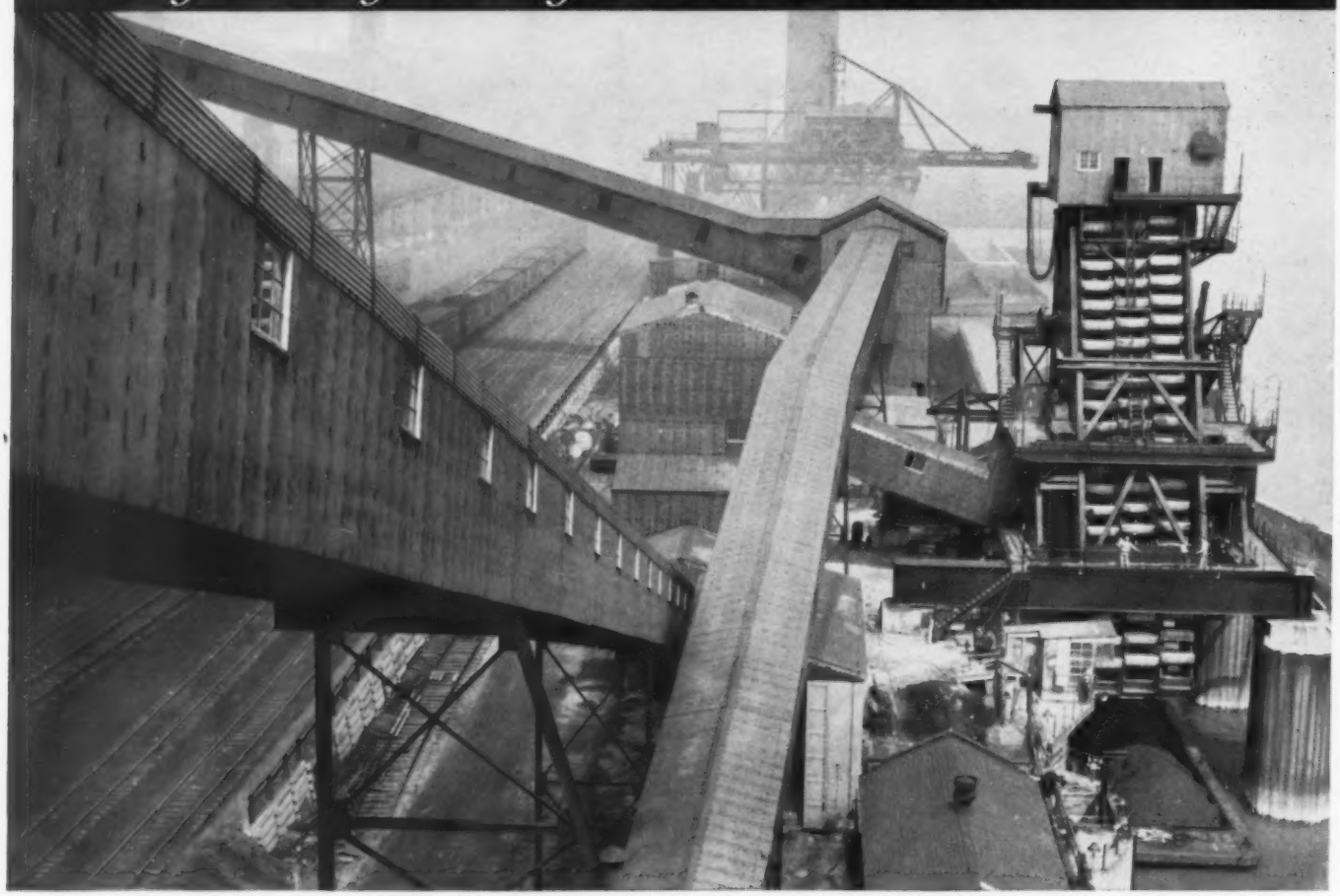
**The tough service** encountered on charging machines is the acid-test of EC&M control. Here, highly repetitive operation under maximum loading brings out the long-life qualities of EC&M Line-Arc magnetic contactor control.

FOR BASIC STEEL MAKING, IT'S EC&M CONTROL

3125-R

## You get Undivided Responsibility for your Material Handling Plant from ROBERTS & SCHAEFER

*Design... Engineering... Fabrication... Construction*



From blueprint to turn-key delivery, Roberts & Schaefer will take entire responsibility for your material handling plant.

You will find at Roberts & Schaefer a unique combination of creative engineering talent, long experience in the specialized material handling field, and large facilities for fabrication and construction.

You tell us the capacity, flexibility and performance you want. Roberts & Schaefer will design and build a plant complete with coordinated processing, distributing and storage systems to satisfy your requirements for operating efficiency and economy.

Whether your material handling project involves a complex system, as illustrated here, or a simple operation, you'll find it well worth while to talk first with Roberts & Schaefer.

ENGINEERS & CONTRACTORS

**ROBERTS & SCHAEFER** *Company*

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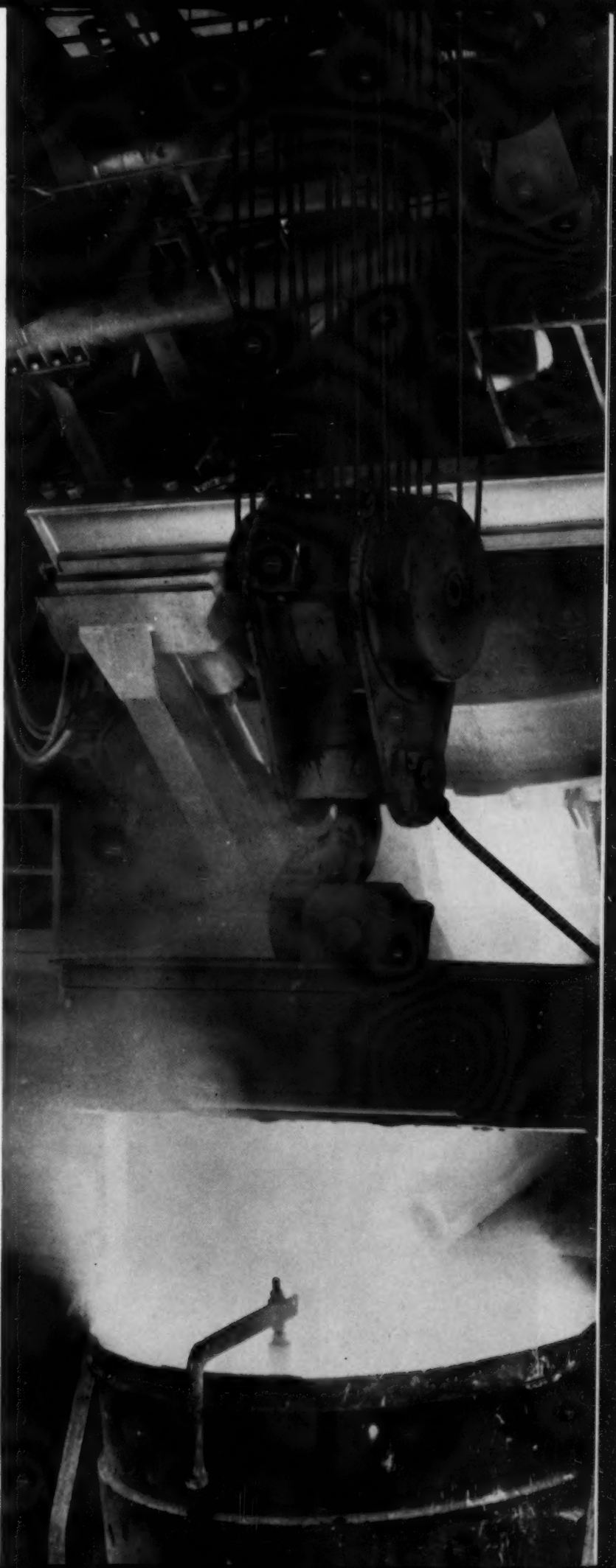
DIVISION OF THOMPSON-STARRETT COMPANY, INC.

# ELECTROHYDRAULIC ARC FURNACE CONTROL



**SHORTER MELT TIME**

. . . for higher yields. Electrode speeds up to 30 ft./min. with safety and stability. Less time to bring electrode down to scrap at start; less time to recover arc after scrap falls away. Rapid short circuit elimination. Less electrode breakage through rapid pull-away on scrap cave-ins.

**INITIAL COST REDUCED**

. . . as much as 50%. Many components necessary for electric system are eliminated. Extremely simple electrohydraulic system uses a minimum of starters, contactors, rectifier systems, etc.

**MINIMUM MAINTENANCE**

. . . because hydraulic cylinders eliminate cable changes, gear train maintenance or replacement. No routine maintenance of control panel.

**PERFORMANCE GUARANTEE**

. . . from the supplier of the most reliable controls to the steel industry for a quarter of a century.

**PROVED SUPERIORITY**

. . . through the experience of leaders in high-quality steels and specialty metals, who are successfully meeting competition with GPE electrohydraulically controlled arc furnaces. Your GPE Controls representative has list of installations.

*Write for descriptive literature*

GPE Controls | A GENERAL PRECISION COMPANY

**GPE Controls, Inc.**
240 E. Ontario Street • Chicago 11, Illinois

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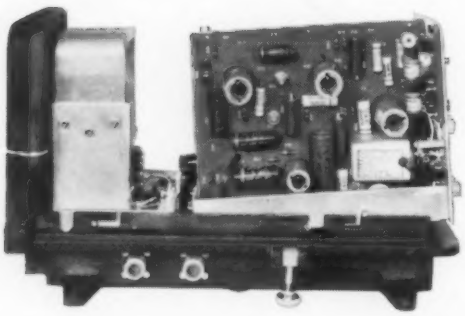
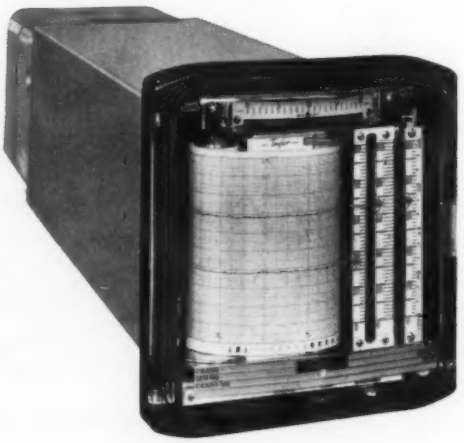
# FROM TO

*From simple temperature measurement to a complete Scanning and Logging system . . . you get accurate, dependable instruments when you specify Taylor*



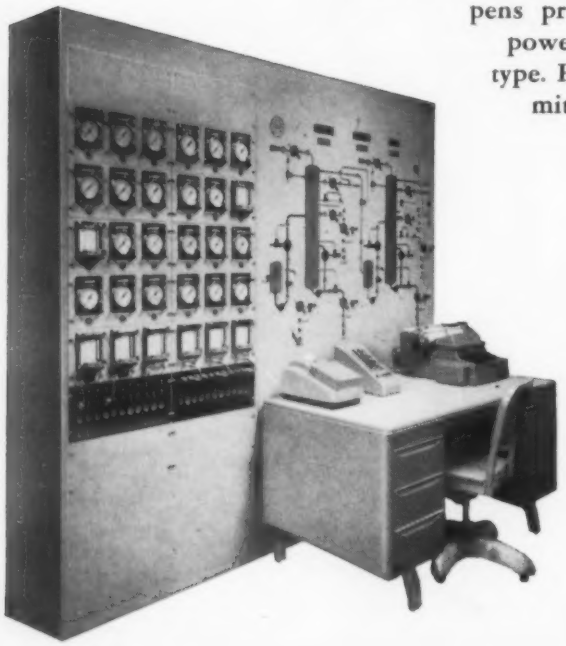
**700T Potentiometer Transmitter**

Converts a DC primary electrical signal into a 3-15 psi pneumatic output for controllers and receivers. Continuous, electronic standardization eliminates slide wires, batteries and moving parts. Plug-in service "cans" permit instant conversion from one type of service to another. Ask for **Bulletin 98262.**



**90J TRANSCOPE* Recorder**

Most convenient, most compact recorder yet developed for modern instrument panels. Front-of-panel control settings permit easy adjustment while recording. "Servomatic" power pens provide 150 times more power than bellows-actuated type. Responsiveness to transmitter output is 0.1%. Ask for **Bulletin 98286.**



**Taylor TRANS-SCAN-LOG* Control System**

Interlocks scanning and logging with process control, enabling an operator to instantly visualize, evaluate and act upon any processing irregularity as it occurs. Scans and logs up to 650 points of measurement. Proven dependable in over three years of field service, the TSL System meets today's requirements for complete process supervision with minimum manpower. Ask for **Bulletin 98268.**

Call your Taylor Field Engineer or write for Bulletins. Taylor Instrument Companies, Rochester, N.Y., and Toronto, Ontario.

*Reg. U.S. Pat. Off.

*Taylor Instruments* **MEAN ACCURACY FIRST**

**SERIES** 5000
For intermittent operation . . . relatively low capacity.

**SERIES** 6000
For continuous operation . . . moderate capacity.

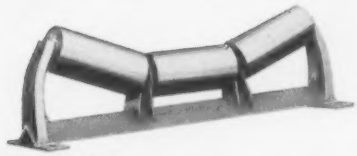
# 759 ways to solve your idler problems

*Link-Belt idlers in standard types and sizes to meet every conceivable belt conveyor need*

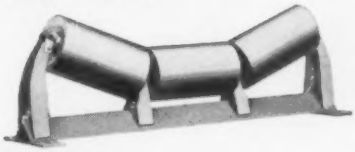
You're sure to find the exact idler to perfectly match your belt conveyor requirements from the complete Link-Belt line of 759 types and sizes.

This broad line enables you to select a size idler that exactly matches your needs, no over- or under-engineering. Power requirements are held to a minimum. In addition, anti-friction bearings, accurate roll alignment and rugged construction provide maximum life for idlers and conveyor belt in light- or heavy-duty service.

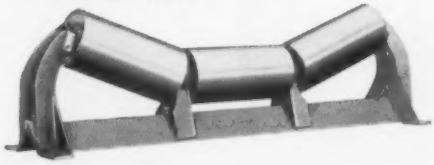
Link-Belt idlers are available with end rolls inclined at 20°, 35° and 45° for a broad range of belt widths. Matching lines of troughed belt rubber cushion, troughed belt training, return belt and rubber tread return belt idlers are also available. Call your nearest Link-Belt office or authorized stock-carrying distributor for full details. Look for CONVEYORS in the yellow pages of your phone book. Or write for Book 2716.



**SERIES** 7000
For continuous operation, higher capacities, heavyweight, abrasive materials.



**SERIES** 8000
For continuous operation, higher capacities, heavier-weight, abrasive materials.



**SERIES** 9000
For continuous service, highest capacities, heaviest and coarsest materials.

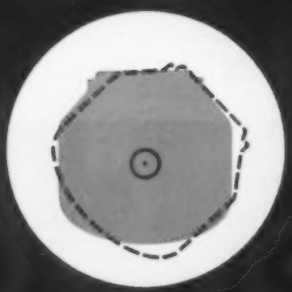
**LINK-BELT**

**BELT CONVEYOR IDLERS**

**LINK-BELT COMPANY:** Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Warehouses, District Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 15.407

**50 BELT CONVEYORS,** employing five different sizes of various type idlers, keep raw materials moving steadily through this sintering plant of Armco Steel.

# in oxygen converters . . .



**Top:** 110-ton capacity furnace (L-D) with PECor-engineered smoke hood and post crane, at McLouth Steel Corporation.

**Center:** World's largest oxygen furnace (L-D) during assembly, for Jones & Laughlin's Cleveland Works.

**Bottom:** All PECor drives are soundly made for assured trouble-free service.

YOU GET FAR MORE THAN THE VESSEL FROM PECOR

**QUALITY** in design and manufacture, reflecting unique experience and constant contact with operating L-D installations. Precision engineered auxiliaries!

**RELIABILITY,** equipment that "stays on the line" making steel.

**SERVICE,** including *immediate response* to field requirements, with service as close as your telephone.

*May we consult with you in the planning stage?*

**Pennsylvania Engineering CORPORATION** NEW CASTLE, PA.

**Sales Representatives:** Wooldridge Company, Burlingame, Calif.
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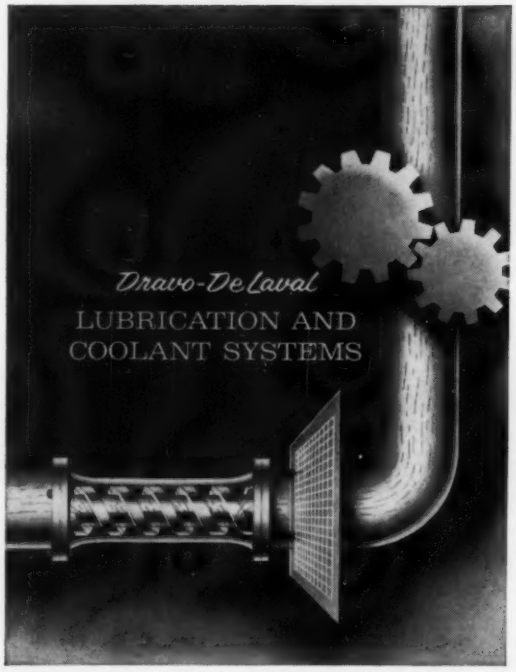
BUILDER OF AMERICA'S FIRST 15 OXYGEN CONVERTERS

*Custom Engineered*

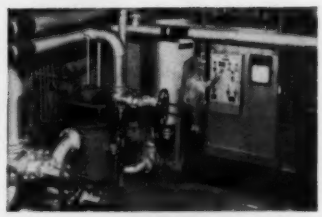
# LUBRICATION *and* COOLANT SYSTEMS




**AVAILABLE NOW.** New brochure discusses the full line of Dravo-DeLaval Lubrication and Coolant Systems. Address your request for Bulletin No. 1451 to Mill Lubrication, Dravo Building, Pittsburgh 22, Pa.

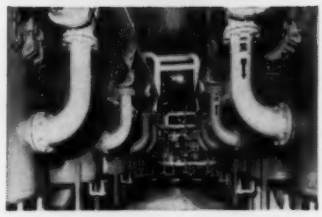
### LUBRICATION SYSTEMS

Engineered to meet your precise needs, a Dravo-DeLaval system is designed for economy of operation. Maintenance is easy, and costly machinery is protected by precision lubrication; temperatures and pressures are held at optimum values.



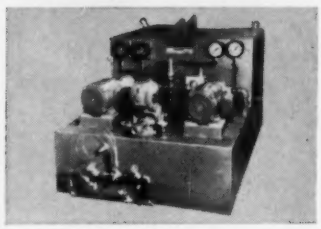
### COOLANT SYSTEMS

Custom engineering involves every system component, from oil reservoirs to the full automatic controls. These coolant systems are designed for hot and cold rolling of ferrous and non-ferrous metals, such as aluminum strip and foil.



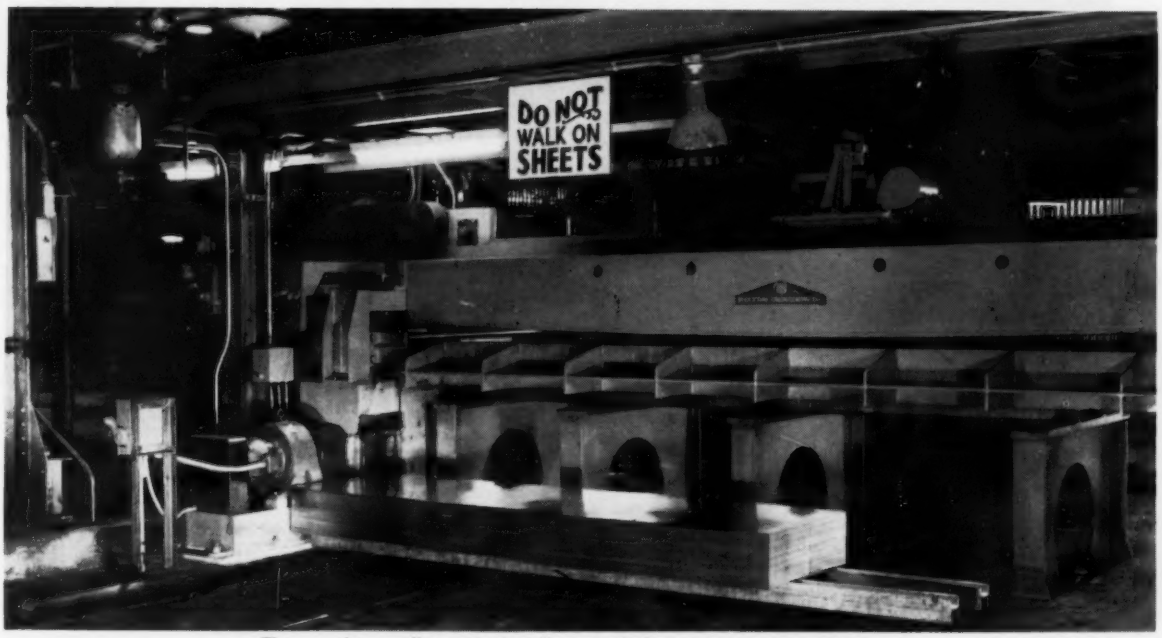
### UNILUBE SYSTEMS

Designed to provide economical, full pressure feed lubrication, the Unilube is a prefabricated "package" which offers all the advantages of the larger custom designs. Capacities range from 1 gpm to 75 gpm over the full range of viscosities.



**DRAVO**
CORPORATION

## THE BUCCICONI MAGNETIC SHEET PILER




This machine efficiently handles steel sheets up to 60 x 200" at speeds up to 450 fpm with an absolute minimum of surface damage.

**BUCCICONI ENGINEERING COMPANY INC.**

PIONEERS AND MANUFACTURERS OF MAGNETIC AUTOMATION MACHINERY FOR HANDLING STEEL SHEET AND STRIP
MANUFACTURERS OF MAGNETIC CONVEYORS, MAGNETIC SHEET PILERS AND DE-PILERS, MAGNETIC ROLLS, MAGNETIC PROXIMITY INDUCTO-SWITCH, THE D. B. MICROGAGE, AND TIN PLATE ASSORTING EQUIPMENT.

**899 GRANT STREET GARY, INDIANA U. S. A.**

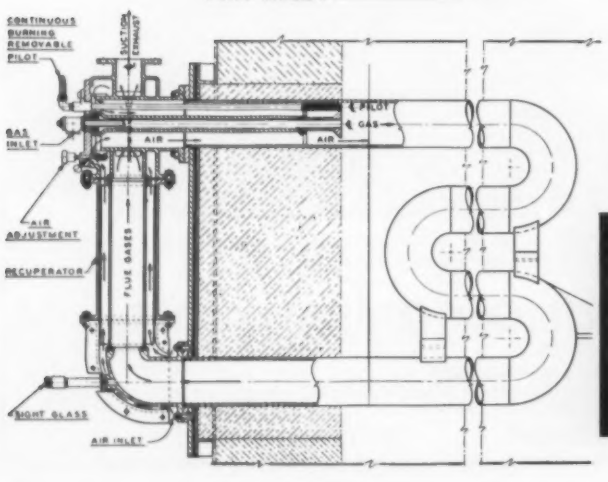
# *Efficient... Dependable*

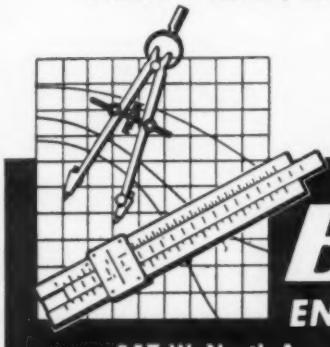
Note compact arrangement of gas inlet, flue gas exhaust, sight glass and fixed externally-lighted pilot.

## *The* BLOOM RECUPERATIVE RADIANT TUBE BURNER

The drawing below shows how the BLOOM RADIANT TUBE BURNER can be mounted on the tube outside of the furnace, without danger of tube overheating. Nozzle is at inside edge of furnace wall. Design provides uniform tube temperature without hot spots, regardless of flow. Recuperator preheats air 600° to 800°F. Operates on clean or dirty coke oven gas, natural gas or butane. Continuously burning pilot assures positive ignition.

One installation was dismantled for inspection after a year's operation on coke oven gas, at furnace temperature of 1750°F. Conditions found were: clean nozzle, clean recuperator, clean "W" radiant tube, no deterioration of nozzle, burner parts or pilot burner.



WRITE for complete details of the BLOOM RADIANT TUBE BURNER

**BLOOM ENGINEERING CO., INC.**

857 W. North Avenue Pittsburgh 33, Pa.

# Your NATIONAL brush man showed this electroplater how to double brush life!

CLIFF BROWER

**PROBLEM:** Rapid brush wear was limiting generator performance.

**RECOMMENDATION:** "National" Brushes Grade BGX.

**RESULTS:** Not one commutator has been stoned or turned in five years. Brush wear has been even, with no selective action or overheating—even up to 20% overloads. Brush life has been doubled.

*Contact your "National" Brush Man*

"National", "N" and Shield Device, and "Union Carbide" are registered trade-marks for products of

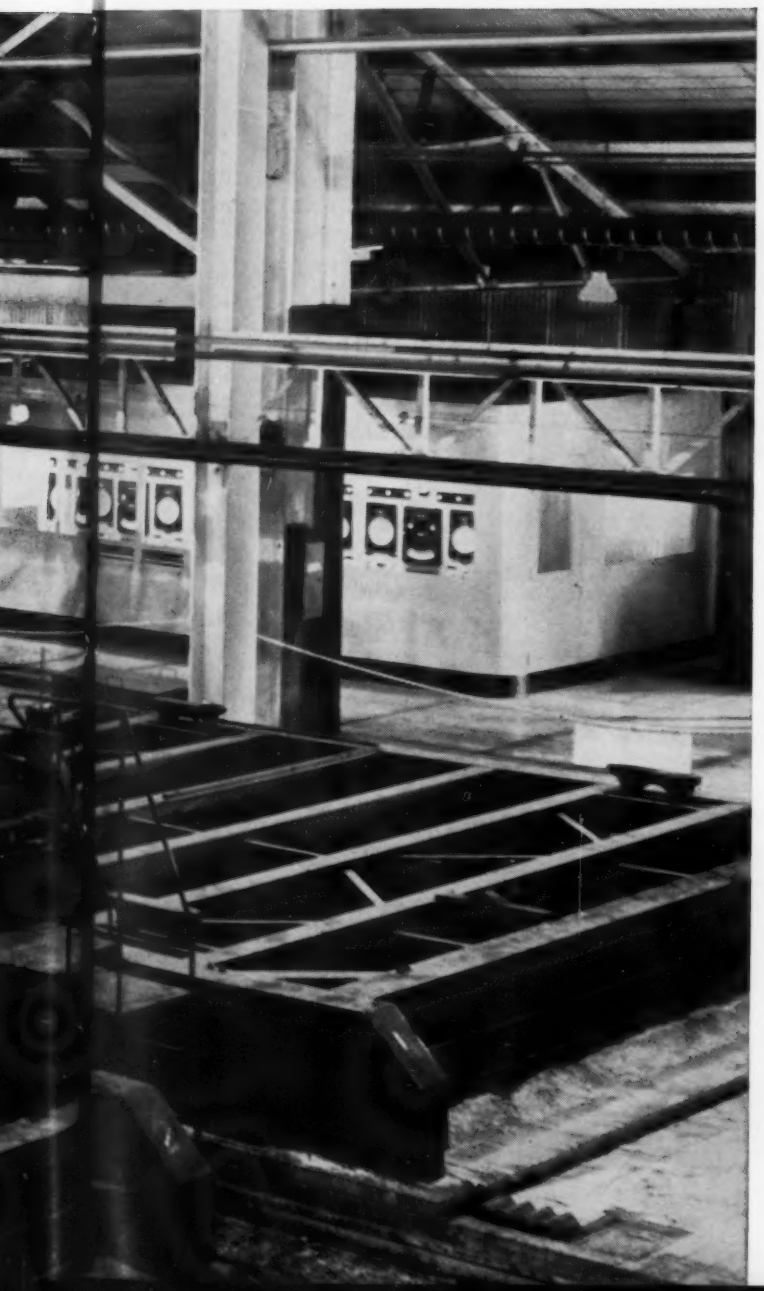
**NATIONAL CARBON COMPANY**
Division of Union Carbide Corporation • 270 Park Avenue, New York 17, New York
IN CANADA: Union Carbide Canada Limited, Toronto

UNION CARBIDE

# New control idea gives heating of soaking

At one of Canada's largest steel companies, a new idea in soaking pit controls permits independent selection of fuel for each pit. The operator uses high Btu fuel for cold steel, and simultaneously feeds less expensive gases to pits that are just holding a heat. He uses only the gas he needs to get the heat he wants. Also, he gets closer control of pit temperature than ever before possible, and ideal protective atmospheres. Your nearby Honeywell field engineer is ready to help you get these advantages in your soaking pit operations. Call him today, he's as near as your phone. MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa. In Canada, Honeywell Controls, Ltd., Toronto 17.

# you flexible, economical pits



Controls like these give flexible and economic heating of 12 thirty-ton capacity soaking pits, permit independent selection of fuel (coke oven gas, blast furnace gas, or a mixture) for each pit, maintain within each pit the turbulent flows necessary for good soaking and top-to-bottom temperature uniformity, and help provide the best possible protective furnace atmospheres. Protective devices built into the system automatically safeguard against failure of power, fuel or compressed air. Stack dampers can be raised manually, even while under automatic control. The system also closes dampers, cuts out combustion air, and reduces gas flow automatically when the covers open.

75th YEAR
PIONEERING THE FUTURE

**Honeywell**

First in Control

SINCE 1885

# 4 High Non-Reversing

# COLD MILL

The Pittsburgh 8½" x 24" x 20" Intermediate Cold Mill illustrated is now in continuous production in the Chicago area with a rated capacity of 18,000,000 lbs. per year.

It can be used for reduction of either non-ferrous or ferrous alloys at your required rolling speeds.

This mill is typical of the modern equipment for the rolling mill industry now being designed and produced by Pittsburgh Engineering and Machine Division for installation in the United States and other countries.

Your inquiries are invited.

*Electric and open hearth steel castings from 1 lb. to 100 tons*

by

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**ENGINEERING & MACHINE DIVISION**

HEAVY MACHINING FACILITIES

Our plant is equipped with a superior complement of well diversified machine tools that are available on a continuing basis for economical machining of heavy castings or the manufacture of auxiliary rolling mill equipment, such as heavy mill tables, furnace pushers, slab depilers, downcoilers, ingot buggies, slab transfers, etc.

*Pittsburgh Steel Foundry Co.*

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**The Ramtite Co.**
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- ☐ Please send a representative to discuss RAMTITE.

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# TSP going strong a

Here is the new 140" roughing and slabbing mill at Lukens Steel's plant in Coatesville, Pa. Other photos on page show applications of "Tool Steel Process" material on equipment in this new mill, particularly in overhead cranes.

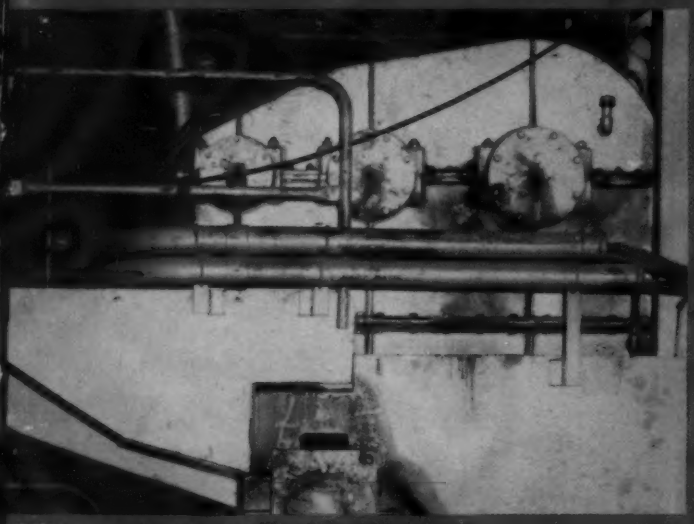
TSP wheels are widely used on all cranes.

75-ton ladle crane and three electric furnace shop cranes completely equipped with TSP gearing.

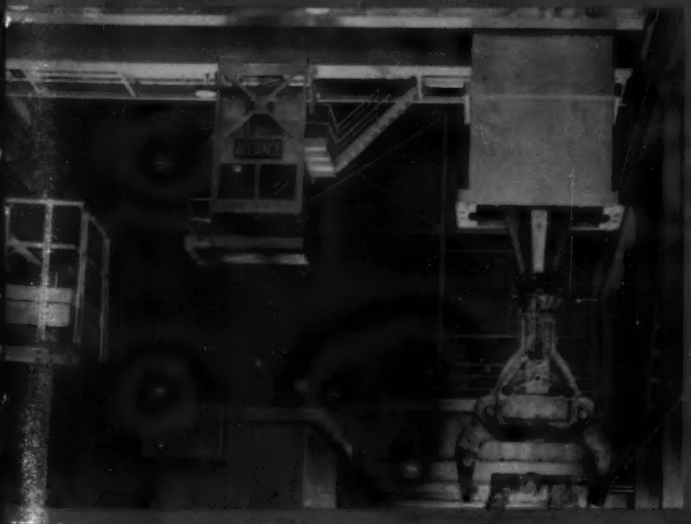
TSP wheels on ingot buggies give characteristic long wear.

# g at LUKENS STEEL

TSP gearing on main hoist speed reduction unit of 75-ton crane.



TSP main hoist gearing used on this soaking pit crane.



World's largest soaking pit crane completely equipped with TSP gearing.

"Tool Steel Process" hardened products are in use at the Lukens Steel plant in Coatesville, Pa. Lukens uses TSP products because they help maintain continuous productivity of their equipment, resulting in dollars saved in maintenance, replacement and down-time costs. The phenomenal wearing qualities of TSP products are a result of a special hardening process which develops a file hard surface to the full depth of permissible wear. The core, refined for toughness and ductility gives tremendous strength. That's why TSP products are unconditionally guaranteed to last longer in the same service than any competitive product. TSP hardened products include gears and pinions for all services, track and sheave wheels, leveller and pinch rolls, shafts and axles, and sprockets.

Write today—comprehensive literature tells you how TSP products can save money for you.

THE TOOL STEEL GEAR AND PINION CO.
CINCINNATI 16, OHIO

MEMBER OF AGMA

AD 1044—Printed in U.S.A.

The standard of quality since 1909 for gears, pinions, rolls, wheels and other hardened products.

# NEW!
# AAF TUBE FILTER

## Combines maximum air cleaning with minimum maintenance

The new AAF Tube Filter is made to order for ventilation systems requiring a high degree of air filtration combined with minimum maintenance. This new unit offers simple disposal of collected dust and simplified design for easy field assembly.

Typical applications are steel mill motor rooms, sewage treatment plants, instrument rooms and paint spray facilities.

### Two different types available

This new unit is available in two types, the Type W and Type S. The Type W Tube Filter uses water to wash the collected dust from inside the bags. The Type S is a high efficiency unit that unitizes a fibrous media supplement inside the cloth bag as the collecting medium.

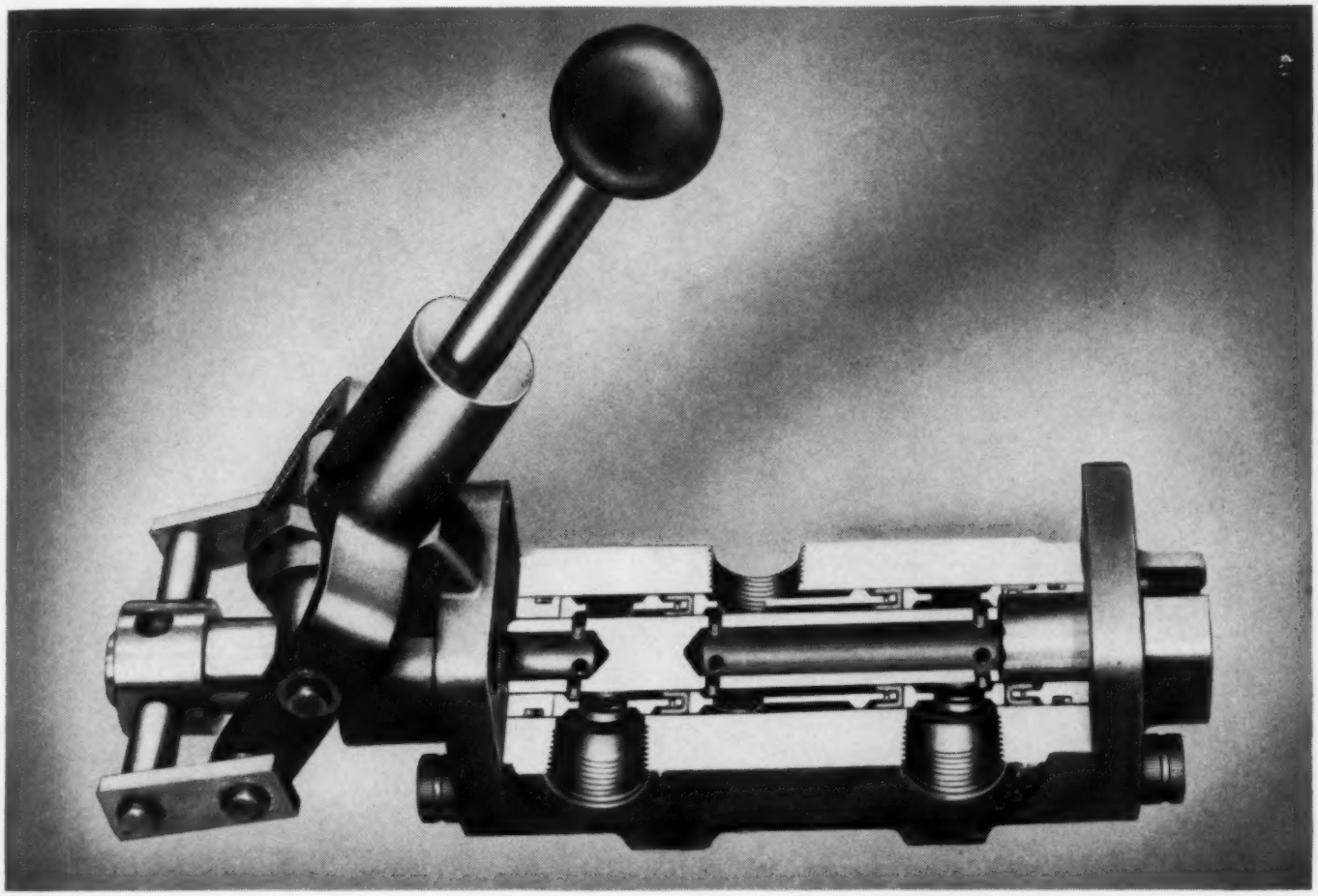
Both types are available in circular or rectangular housings or can be designed to fit a given space.

For complete product information, call your local AAF representative or write direct for AAF Tube Filter Bulletin No. 222. Address: Mr. Robert Moore, American Air Filter Company, Inc., 302 Central Avenue, Louisville, Kentucky.

AAF **American Air Filter**

BETTER AIR IS OUR BUSINESS

**DOWN WITH DOWN-TIME!** Homestead® Durable-Seal Operating Valves *up* your plant efficiency with long valve life and maintenance-free operation, where water, oil, or soluble oil is the operating medium. Here's why: Homestead's simple design does the trick. One piston instead of two



means fewer moving parts, less wear. Easy operation, positive seal, and longer life are built in, because sealing lips of leather "U" packings are hydrostatically balanced by the *same* pressure on both sides of the lip. No shear, no distortion, no undue wear, as ports pass over leathers. And, what little maintenance may be necessary can be done in the line—saving time and temper. For details on Homestead Hydraulic Operating Valves, mail coupon.

hv

**HOMESTEAD VALVE MANUFACTURING COMPANY**
"Serving since 1892"
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Please send Reference Book 39-6 and prices on all types of Homestead Operating Valves. 160

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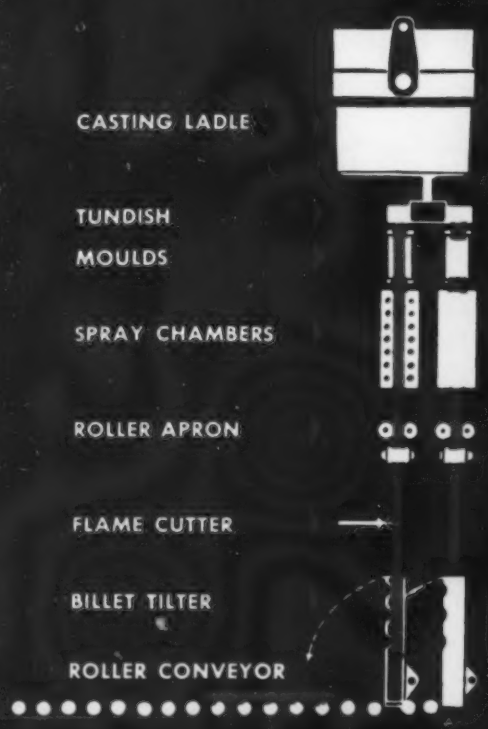
# DEMAG

## CONTINUOUS STEEL-CASTING PLANTS




EIGHT-STRAND CASTING PLANT

in full operation at the Terni iron and steel works in Italy since 1958

Developed to the Junghans system in co-operation with Messrs. Mannesmann and Böhler

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U. S. - Representatives:
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One Gateway Center, Pittsburgh 22, Pa.

# Foreign Digests

Complete translations from which these condensations were prepared are available from Henry Brutcher, P.O. Box 157, Altadena, Calif., to whom all correspondence should be addressed.

## "RELATIONSHIP BETWEEN BLAST TEMPERATURE AND TEMPERATURE DISTRIBUTION OVER THE HEIGHT OF THE BLAST FURNACE"

by I. F. KOVAL', Alchev Mining and Metallurgical Institute. (Translation No. 4696 from Izv. Vuz-Chern. Metallurgiya, May, 1959)

Δ INVESTIGATIONS with an experimental 1/20 scale model furnace have confirmed the irregular distribution of gas temperatures over the height of the furnace, which has been established by blast furnace operation and by the experiments of other investigators.

The sharpest decrease in temperature occurs over the lower part of the furnace (the hearth and the lower region of the stack), while during the ascent of the gases in the stack the fall in gas temperature is less rapid.

In the middle region of the inwall section, which occupies 40 per cent of the height of the stack, the temperatures vary within the limits 1290 to 1560 F. The fall in temperature over this section is only 90 to 215 F.

In the region just below the stock line, there is also a sharp decline in the gas temperatures, but the fall here is not so pronounced as in the lower level of the furnace.

Tests results indicated that, with decreased blast temperatures, the temperature of the gases in the stack is higher, but lower at the upper end of the belly. Conversely, with increased blast temperatures the stack is cooler (even with the same amount of coke) but the temperature in the lower part of the furnace is increased.

Other conditions remaining constant, the temperature at the throat increases by 45 to 54 F with a decrease in blast temperature of 180 F.

With a light ore charge, the heat exchange occurs over a greater depth of the stack and the temperature alters gradually; but with a heavier ore charge, the transition occurs more rapidly (the zone of moderate temperature increases).

With increased wind blown and constant blast temperature, the temperature over the total height of the furnace is raised, agreeing with the general law of the distribution of heat in a furnace. One of the basic conditions of this is the increase in the amount of gases formed in unit time.

## "ELIMINATION OF HYDROGEN AND NITROGEN FROM STEEL BATHS BY FLUSHING WITH ARGON"

by M. IMAI, T. WATANABE, Y. KATAYAMA, T. NAKAYAMA and K. OI, Kawasaki Steel Co. (Translation No. 4789 from Tetsu-to-Hagane, Vol. 43, 1957, No. 3)

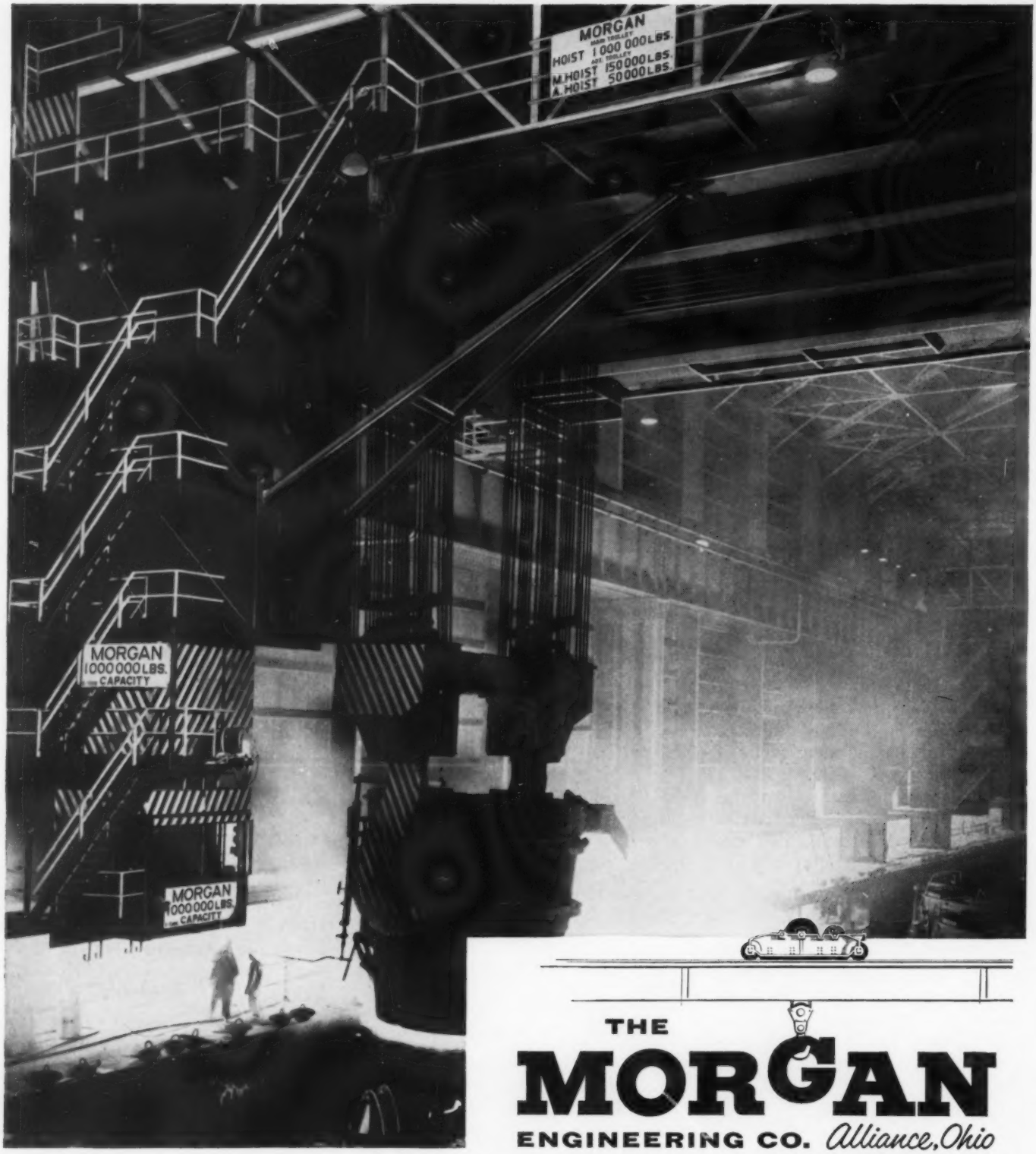
Δ THE hydrogen content of low-alloy steels such as the Ni-Cr-Mo steel made in the basic electric arc furnace is relatively high and often results in white spots and hairline cracks. Using a 20-ton arc furnace, a series of experiments were carried out in an attempt to reduce the hydrogen content in the metal by means of flushing with argon. As a result, electric furnace steel of high quality for purposes of forging was obtained.

For each heat, six cylinders, each containing 250 cu ft of argon, were used. A steel pipe was connected to a set of two argon cylinders. With this arrangement, the argon was introduced simultaneously through three pipes into the molten steel under 28–56 psi pressure at the rate of 70 cfm. The melt boils as a result of argon injection. The argon was introduced at the final stage of reduction just before tapping, and after the alloy additions had been made. The heat was tapped immediately to avoid subsequent hydrogen absorption. Gas and chemical analyses were made at regular intervals.

It was found that hydrogen can be reduced drastically with nitrogen being maintained around 0.0007 per cent. Oxygen can be reduced slightly and the effectiveness of refining increased. A hyperbolic relationship between hydrogen and the volume of blown-in argon was established. A correlation was found between hydrogen and partial pressure of the humidity in the air.

### OTHER AVAILABLE TRANSLATIONS

**"Desulphurization of Hot Metal Outside the Blast Furnace,"** by M. I. Gromov and others, Metallurg, March, 1958. Review of currently used equipment and methods for removal of sulphur from pig iron outside the blast furnace their shortcomings. Desulphurization in authors' rotary furnace; factors influencing the treatment. Data on lime composition, particle size, and consumption; speed of rotation of furnace; coke breeze mesh size and rate of addition to iron. Nomogram for reading the optimum rotation speed in relation to furnace diameter and metal viscosity. General precautions to be taken. (Translation No. 472B)

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# MORGAN
ENGINEERING CO. *Alliance, Ohio*
500 BROADWAY

## Heavy equipment for industry

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Soaking Pit Cranes
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Special Steel Mill Equipment
High and Low Type Charging Machines

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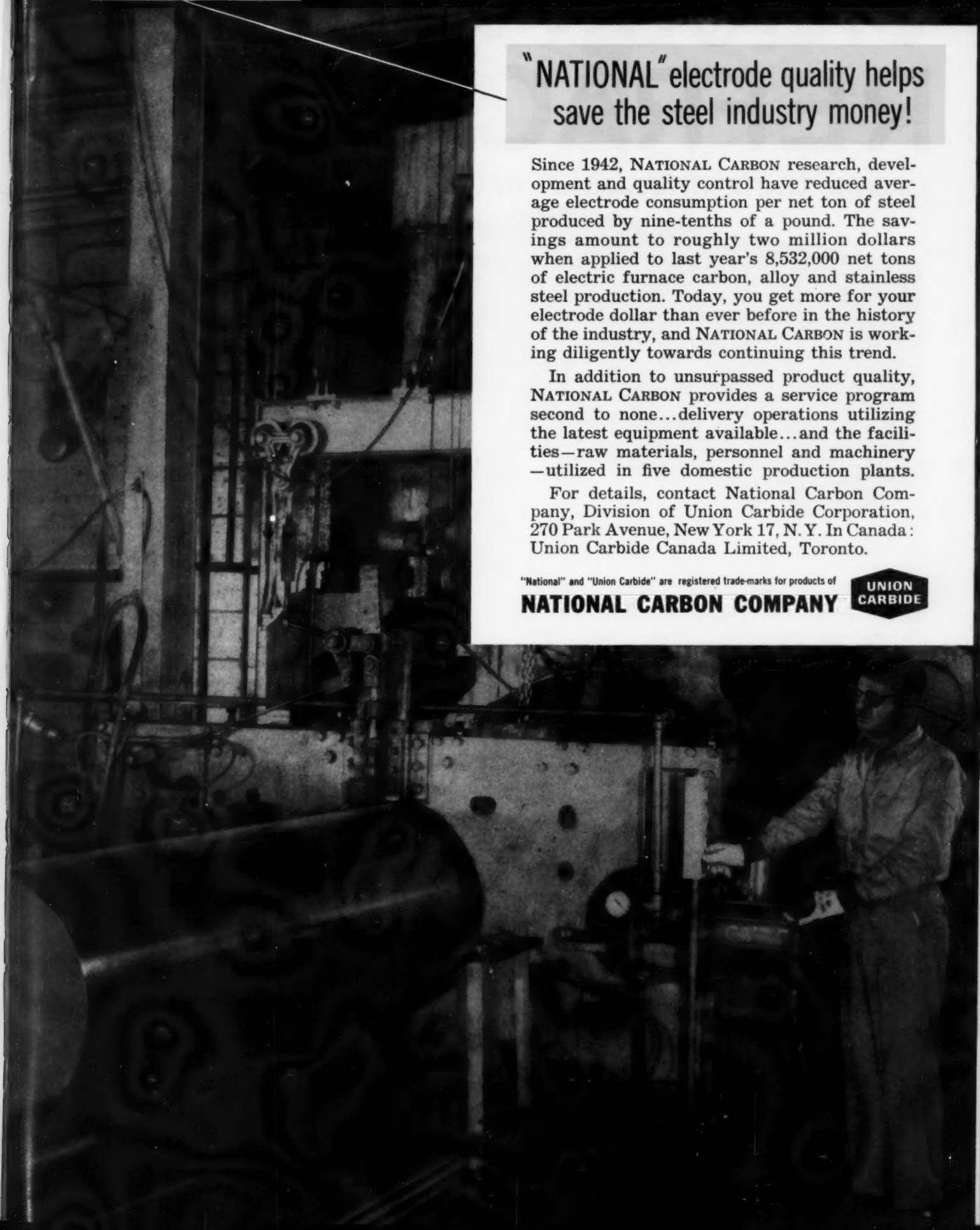
MAJOR REASONS FOR SPECIFYING NATIONAL ELECTRODES...

**QUALITY** SERVICE · DELIVERY · FACILITIES!



## "NATIONAL" electrode quality helps save the steel industry money!

Since 1942, NATIONAL CARBON research, development and quality control have reduced average electrode consumption per net ton of steel produced by nine-tenths of a pound. The savings amount to roughly two million dollars when applied to last year's 8,532,000 net tons of electric furnace carbon, alloy and stainless steel production. Today, you get more for your electrode dollar than ever before in the history of the industry, and NATIONAL CARBON is working diligently towards continuing this trend.

In addition to unsurpassed product quality, NATIONAL CARBON provides a service program second to none...delivery operations utilizing the latest equipment available...and the facilities—raw materials, personnel and machinery—utilized in five domestic production plants.

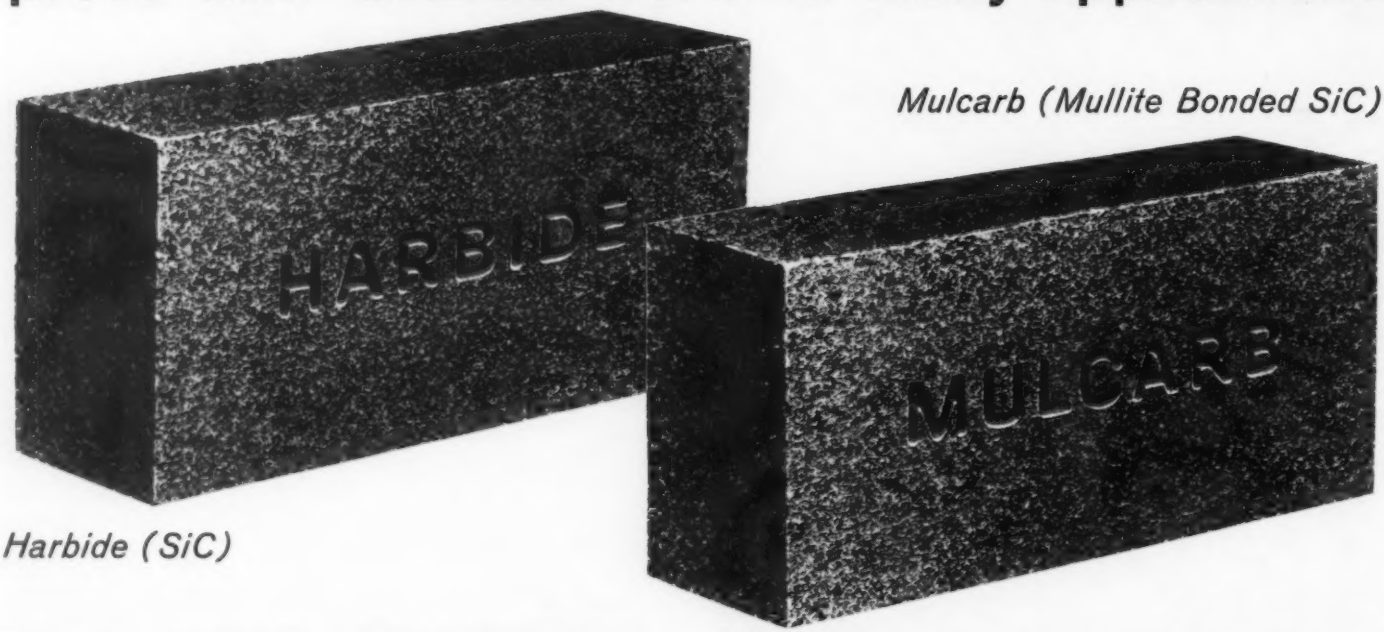
For details, contact National Carbon Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. In Canada: Union Carbide Canada Limited, Toronto.

"National" and "Union Carbide" are registered trade-marks for products of

**NATIONAL CARBON COMPANY**

UNION CARBIDE

# HARBISON-WALKER
# SILICON CARBIDE REFRACTORIES
## prove their unusual worth in many applications



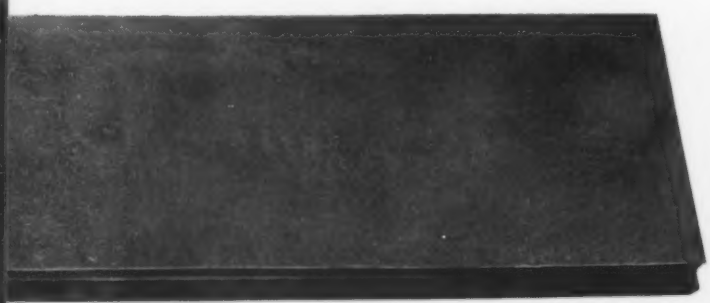

*Mulcarb (Mullite Bonded SiC)*

*Harbide (SiC)*

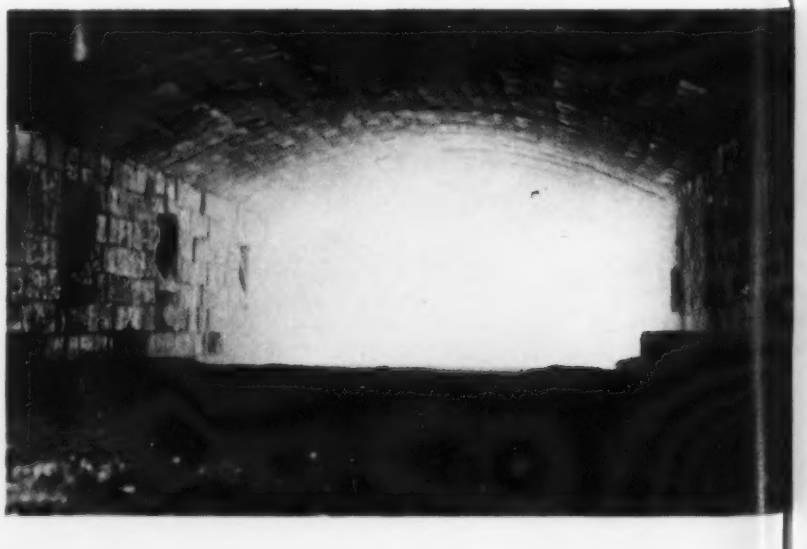
By taking advantage of particular properties of these brands and their specialized modifications for various specific uses, excellent service is regularly secured. These benefits are attributable to the singular combinations of physical and chemical properties of these silicon carbide refractories, unmatched by the many other types and classes of commercial refractories.

Physical properties possessed to the maximum degree by Harbison-Walker silicon carbide refractories make them best suited for many uses. Briefly these properties are—High Thermal Conductivity—Great Resistance to Mechanical Abrasion over a wide range of temperatures—Resistance to Various Fluxes—High Temperature Strength—Low Thermal Expansion and Low Spalling Tendency. Their increased resistance to oxidation and their volume stability under severe temperature conditions contribute further to the noteworthy achievement in the development of these Harbison-Walker brands.

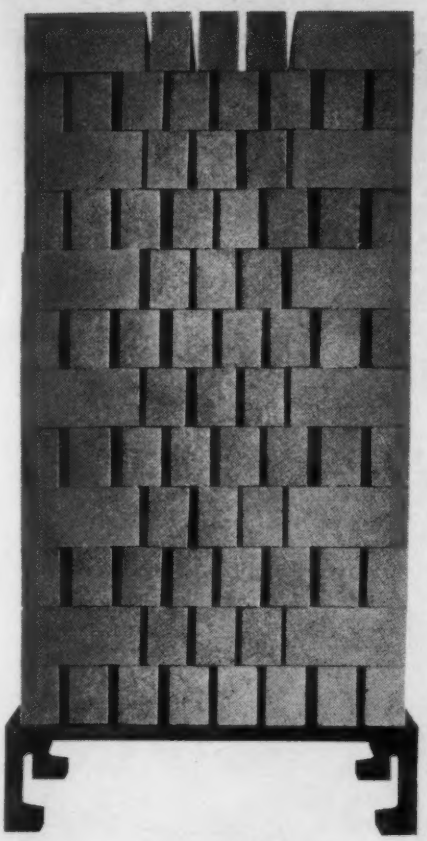
Illustrated in the following are typical uses and properties of primary importance in the accomplishment of superior results in refractory practice:

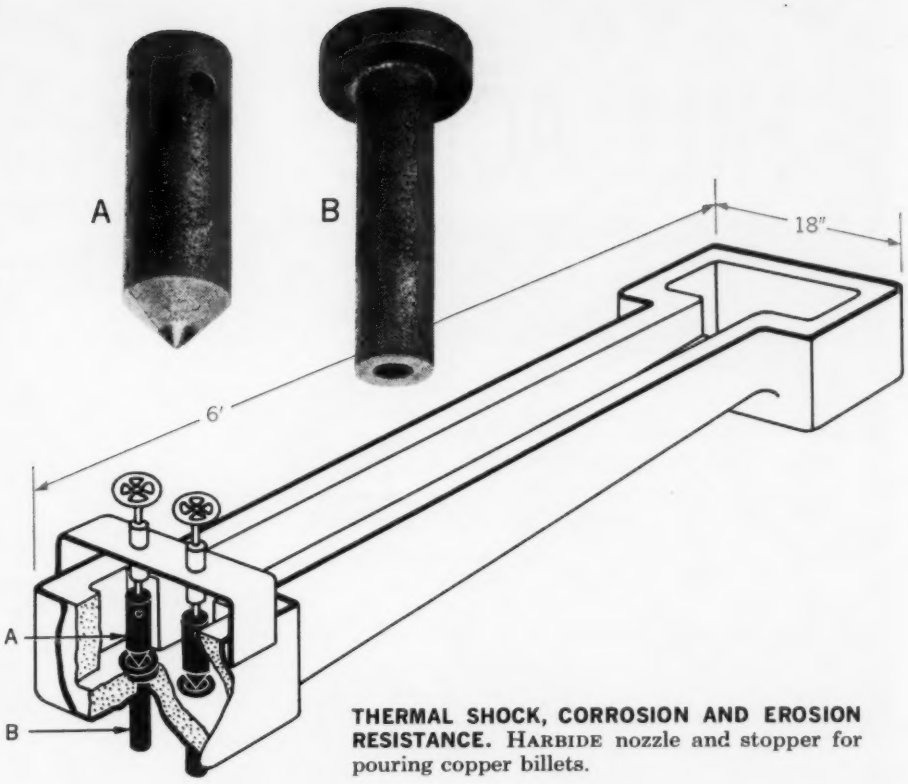


**HIGH THERMAL CONDUCTIVITY.** Large thin HARBIDE muffle tile for zinc refining furnace.



**ABRASION RESISTANCE.** HARBIDE blocks after long service in floor of heating furnace.





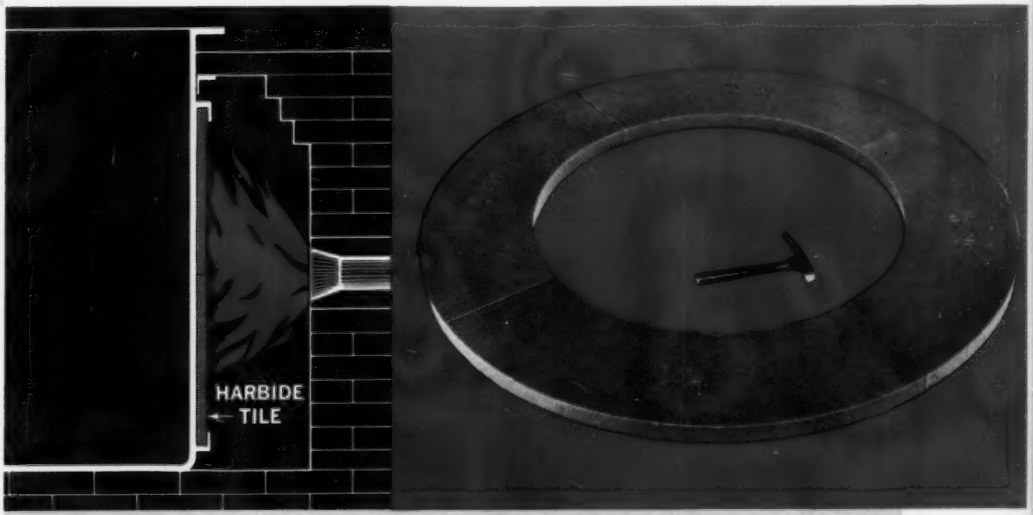

**THERMAL SHOCK, CORROSION AND EROSION RESISTANCE.** HARBIDE nozzle and stopper for pouring copper billets.

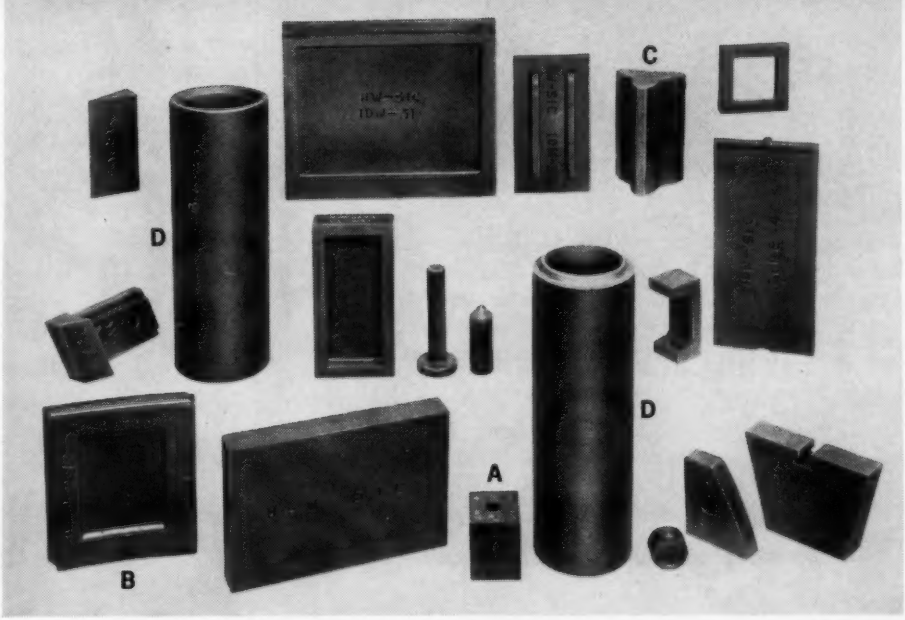
**HIGH TEMPERATURE STRENGTH.** HARBIDE setter tile and supports, with heavy brick load, fired at Cone 18 makes many trips through tunnel kiln.

**CORROSION RESISTANCE.** Protection against burning, with advantage of high heat transfer.

**RESISTANCE TO DUST ATTRITION.** (far right) Plate-type HARBIDE orifice for blast furnace raw gas scrubber.

**VERSATILITY.** Group of H-W silicon carbide shapes shown below, right, includes (A) tapping block (B) muffle tile (C) trefoil skid rail and (D) large tubes.

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**General Offices: Pittsburgh 22, Penna.**

*World's Most Complete Refractories Service*

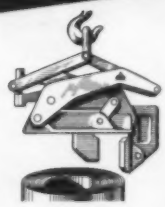
HW-60-15

# HILL ACME

## AUTOMATIC LIFTERS

We are offering a complete line of standard and special lifters from improved designs, resulting in a 50% increase in storage efficiency in many cases.

HILL ACME Automatic Lifters are made of alloy steels with accompanying weight reduction and increased safety factors. They are built to machine tool tolerances by a 75 year old company with an enviable reputation in the field of metals.



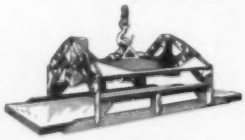
Vertical Coil Lifter

Ingot and standard lifters to meet your requirements

We Welcome Your Inquiries on:

- Coil Lifters
- "C" Hooks
- Rack Lifters
- Billet Lifters
- Sheet Lifters
- Plate Lifters
- Bar Lifters
- Ingot and Ingot Mould Lifters

Bar tongs — single or spreader to specifications



Sheet Lifters — Mechanical and motorized styles for handling flat sheets and plate

Also manufacturers of: HILL Surface Grinders, Polishing Machines, Bar-Billet Shears, Alligator Shears, Rotary Scrap Shears, ACME Forging Machines, Tapping Machines, HILLCO Chasers, CLEVELAND Knives and Shear Blades.

"C" Hook, single or multiple, for horizontal coil lifting

Slab Lifter — Motorized mill type

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MATERIAL HANDLING DIVISION

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SPRAYING SYSTEMS CO.

# DESCALING NOZZLES

in hardened stainless steel

in stainless steel with tungsten carbide orifice tips

**compact**
modern design . . . only ½ to ⅓ the size of old nozzle types

**advanced hydraulic design**
gives extremely sharp, hard hitting FLAT SPRAY pattern

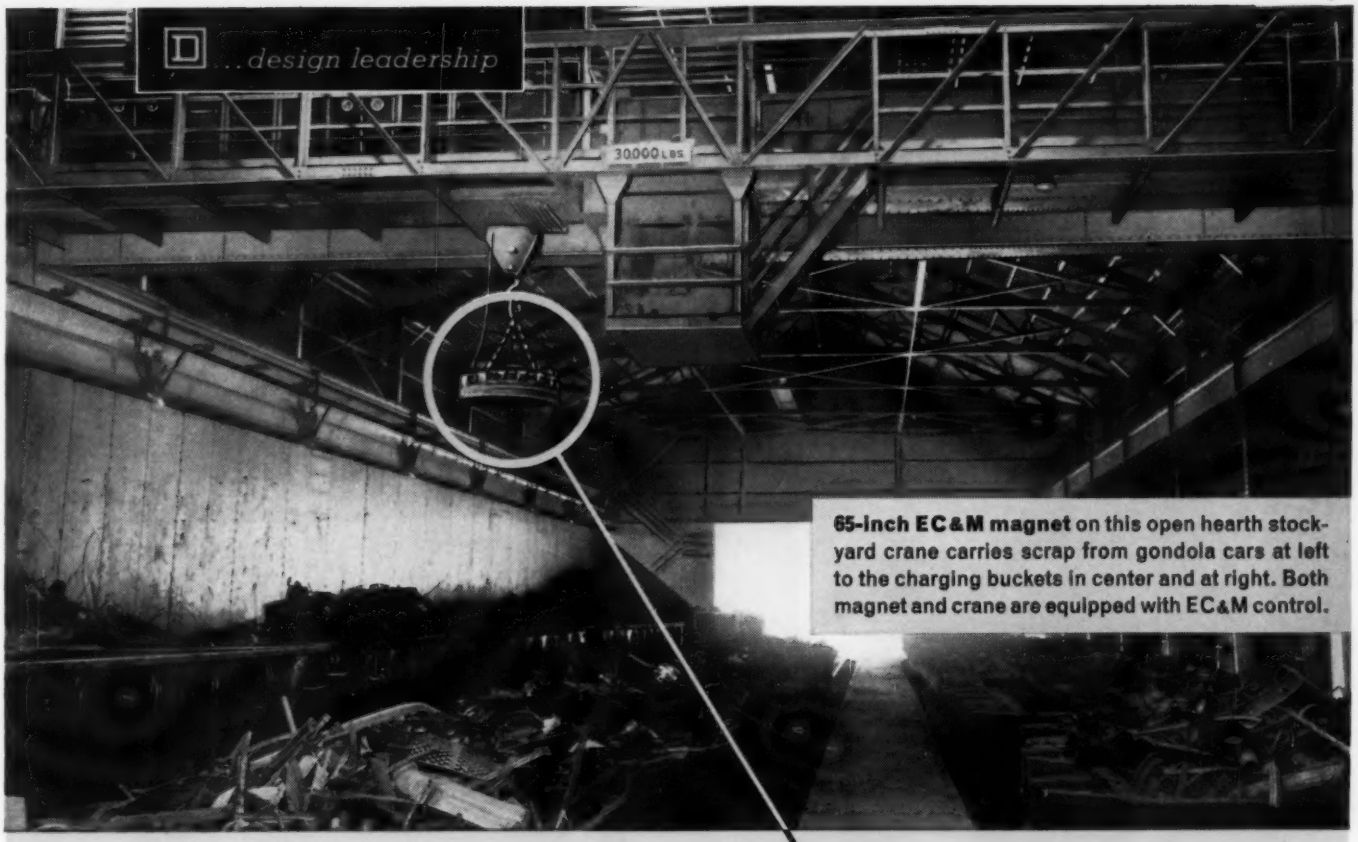
**large open orifice**
keeps clogging to a minimum

Here are spray nozzles with sharp, high-impact flat spray patterns to materially improve your descaling operations. They're small in size for easier installation and better performance. The unusually large orifices go far in solving clogging problems. Made in all capacities in hardened stainless steel for high resistance to sand and silt. And for maximum possible abrasion resistance, they're also made with Tungsten Carbide orifice inserts. Just write . . . we'll be happy to send you complete Descaling Spray Nozzle information.

**HEAVY DUTY LINE STRAINERS**

Spraying Systems now offers line strainers in a full range of sizes . . . with threaded connections up to 4" N.P.T. size . . . and flanged connections in 3", 4" and 6" pipe size. Designed for operation at pressures up to 125 psi. Unusually large screen areas for high volume capacity. Heavy duty, reinforced screens. Easily flush-cleaned through bottom plug or drain cock. Write for Bulletin 94.

SPRAYING SYSTEMS CO.
3262 RANDOLPH STREET • BELLWOOD, ILLINOIS




**65-inch EC&M magnet** on this open hearth stock-yard crane carries scrap from gondola cars at left to the charging buckets in center and at right. Both magnet and crane are equipped with EC&M control.

# EC&M ALL-WELDED Magnets Give EXTRA Lifting Power

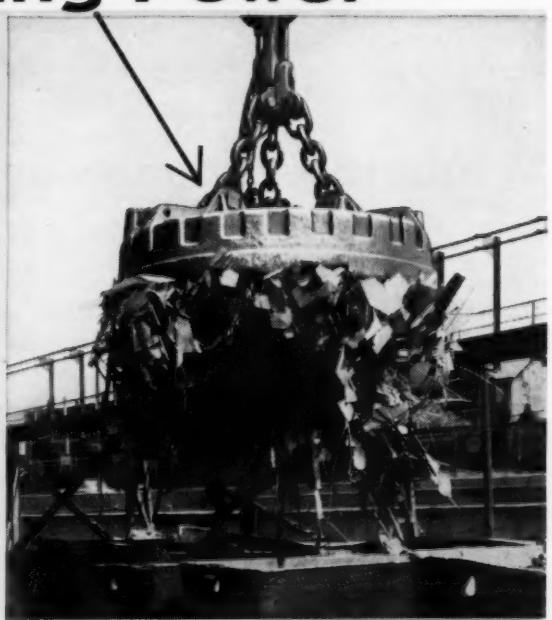
***and Extra Lifting Power means Lower Handling Costs***

• You get extra lift with EC&M all-welded construction. Because the pole shoes are welded in place, they fit more snugly — and they stay that way. Recesses for bolts are eliminated. The result — a more efficient magnetic path, with the entire face of the magnet effective for lifting.

EC&M welded magnets give you other advantages, too. The continuous weld makes them completely water-proof. They have greater impact-resistance, are better able to take the hard knocks of mill operation. If outer leads should be damaged, solderless connectors under protective covers simplify replacement.

EC&M lifting magnets are available in diameters from 39 to 80 inches. Magnets with bolted construction are also available when desired, as well as light-weight magnets for fast-moving mobile cranes. For any magnet, it makes sense to specify an EC&M controller.

***Write for details! Bulletin 1300 gives information on the complete line of EC&M magnets and controllers***



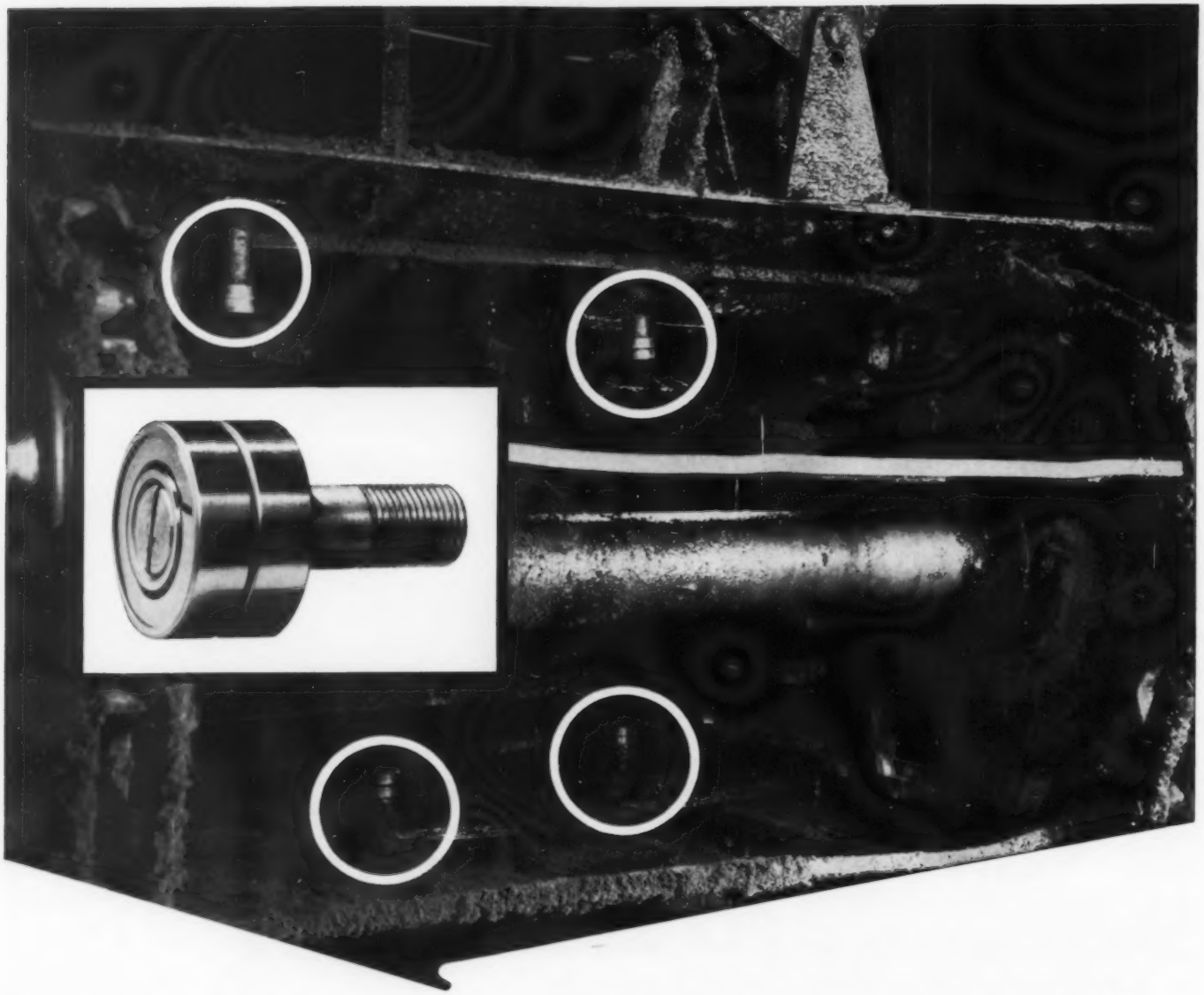
**Close-up view** shows EC&M magnet loading scrap into the charging buckets. The special low-carbon steel housing has high permeability, contributes to extra magnet efficiency.

**SQUARE D COMPANY**

EC&M DIVISION • CLEVELAND 28, OHIO

***wherever electricity is distributed and controlled***

4928



# When thrust loads overpowered original bearings... Bearings, Inc. had the answer!

The original bearings on this automatic machine failed after a short time because they weren't designed to take the thrust loads to which they were subjected. Bearings, Inc. engineers designed and had built a special stud on which were mounted two permanently lubricated and sealed ball bearings.

To keep the cost of this design to a minimum "Locktite", a permanent bonding agent, was used to hold the bearings to the stud. This eliminated shoulders, locknuts or rings yet the bond is as strong as the best press fit.

This installation has now been in operation for many months with no failures reported.

This is not an isolated example of our services — surveys of bearing requirements, inventory control, application engineering, maintenance schedules and procedures are a regular and continuing part of our service to all customers to whom we supply replacement bearings.

*Tell us how we can help YOU!*

**A recent acquisition*

*Providing bearing service in the North* →

## BEARINGS, INC.

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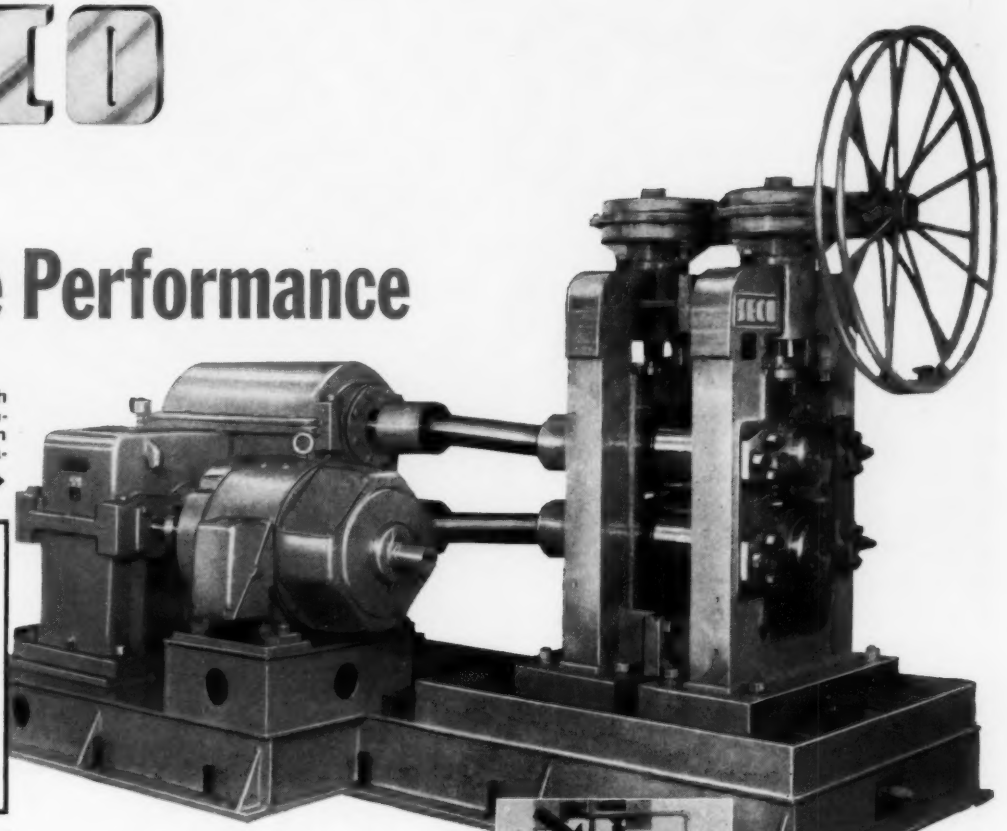
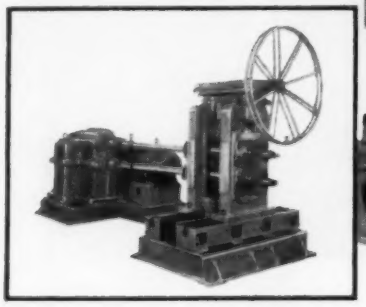
Whatever your requirements . . . SECO's staff of trained engineers can help you solve any special Mill problem you may have . . . from creative designing through installation (including *all* required auxiliary equipment).

Should your problem involve a special Cluster Mill (to accommodate either ferrous or non-ferrous metals), or a Hot Rolling Mill that bonds non-ferrous metal to a steel base . . . SECO can supply.

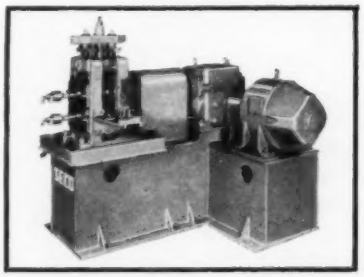
# *Custom Built* HOT ROLLING MILLS *by* SECO *assures* Predictable Performance

A special, custom-built 2-high Hot Roll Flattening Mill for non-ferrous metals. (Can be built in 2 or 4-high types or a combination of both.) ▶





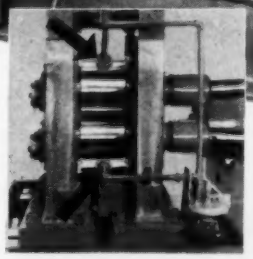
▲ A SECO designed and built Bi-Metal Bonding Mill on movable mountings.



▲ A 6-inch, 2-high Wire Flattening Mill for single or tandem use.

**Special Features:** ▲

- Water-cooled chocks for lubrication
- 900° F. rolling temperature
- Hand wheel screw-down (adaptable for power)
- Special alloy steel rolls
- Timken Tapered Roller Bearings
- Can be built for 8, 10, 12 or 16-inch widths.



◀ Mill is equipped with two gas jets as a means for pre-heating rolls (see arrows).

SECO

**STEEL EQUIPMENT COMPANY**

P. O. BOX 737, WARRENSVILLE STATION
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**SECO STEEL MILL EQUIPMENT**

- Leveling and Shearing Lines
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- Tension Reels for Strip Polishers
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- Slitting Lines
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*Affiliated with Lee Wilson Engineering Co., Inc.*

# CRACK THE PROBLEM OF HANDLING NEXT WINTER'S FROZEN COAL—NOW!

## Pennsylvania's Frozen Coal Cracker is the answer

If frozen coal handling is one of your winter problems—you can solve it with a Pennsylvania Frozen Coal Cracker.

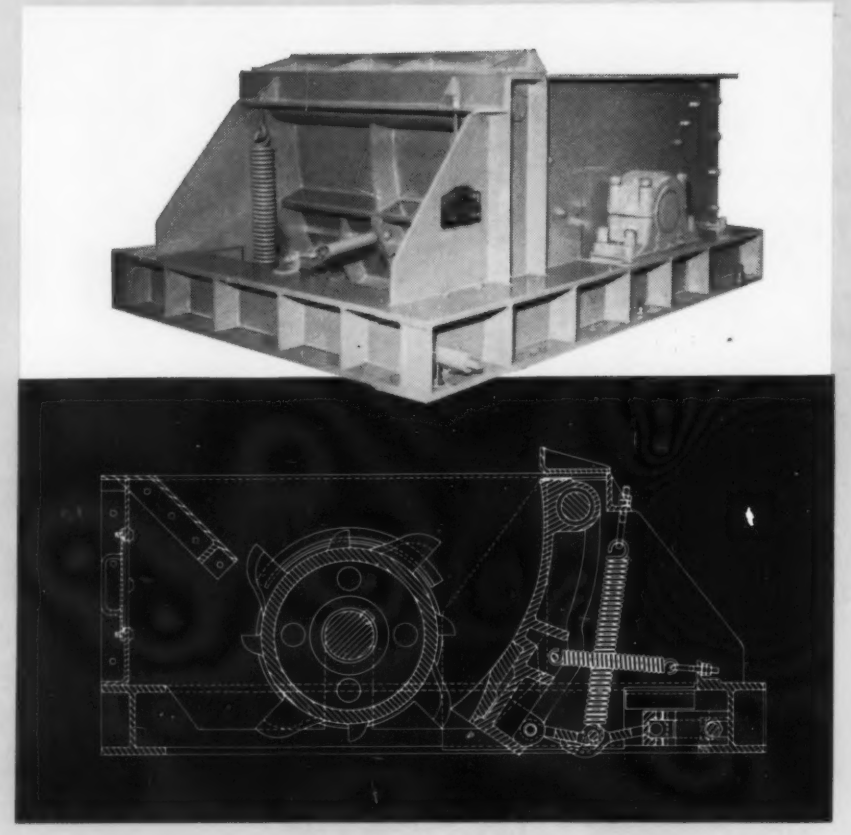
This is the specially-developed cracker with a *wide feed opening*, permitting use of *open-throated* hoppers. Dumped directly into such hoppers (no need for grates) the frozen masses of coal work their way freely to the hopper bottom where they are broken up by blows from the cracker's special teeth.

A uniform product with limited top size and minimum fines is fed conveyors, protecting them from overload, and insuring a continuous flow of coal from unloading point to yards, or yards to plant.

Cracker can be started up with full hopper; operates satisfactorily under choke feed.

Breaker plates are designed so that in warm weather they can be opened up, permitting the coal to pass through without operating the crusher.

Mechanically simple, built-in tramp iron protection. Low headroom required makes the Frozen Coal Cracker ideal to fit into existing hoppers. Drives can be engineered to fit in a minimum of space. Capacities up to 1200 tons per hour. Available in single or twin units.



### ACT NOW

Don't be plagued by hopper jams, overloaded conveyors, slowdowns and high labor costs. Act now. Write for new Bulletin 2013.

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BATH IRON WORKS CORPORATION
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*Over 50 years' concentrated experience in all types of material reduction makes Pennsylvania your best source of crushers and engineering advice and service. Call on Pennsylvania with your next crushing problem. Representatives from coast-to-coast.*

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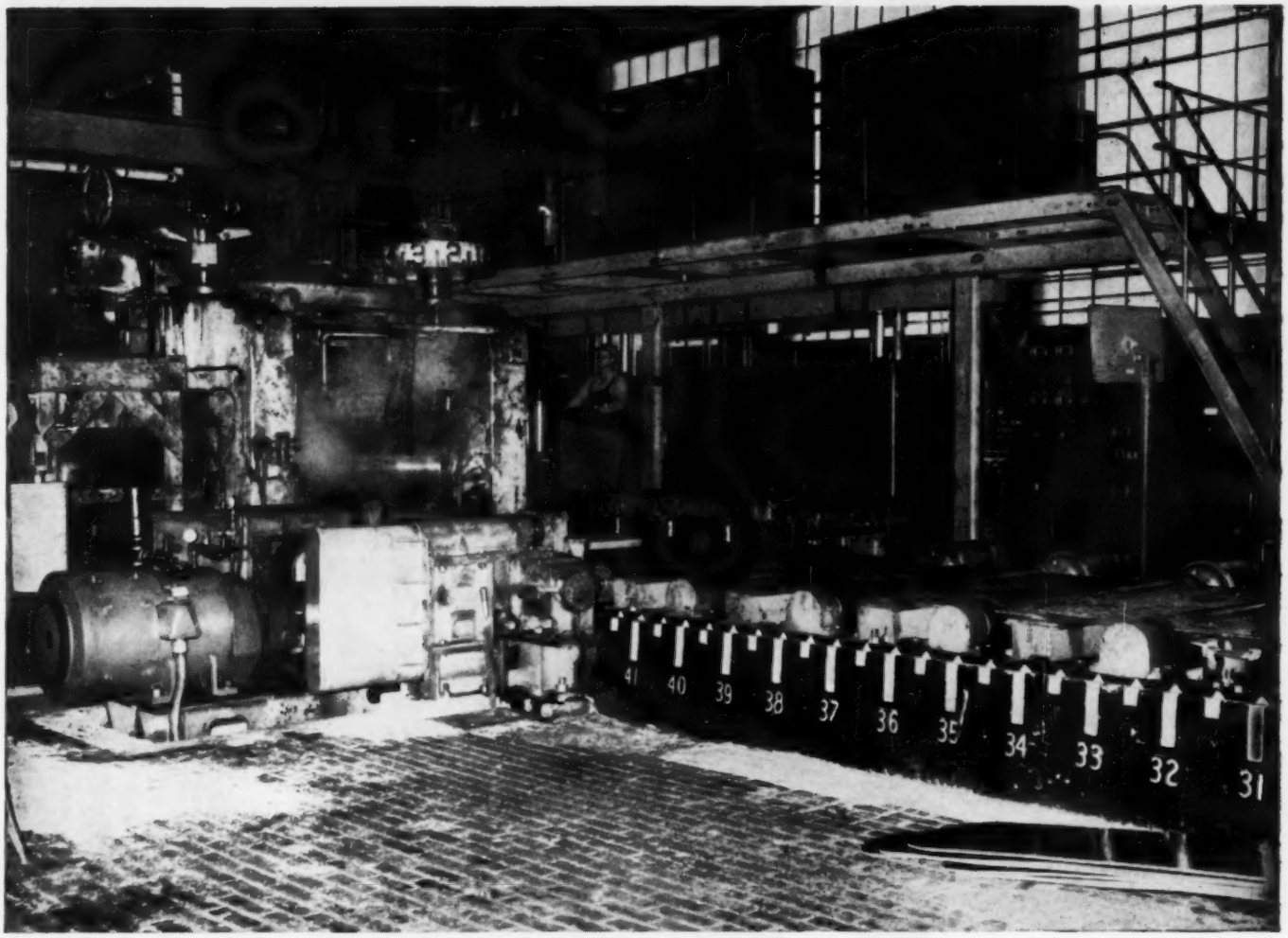


Packaged M-G sets and controls are located right at the hot mill in Revere Copper and Brass, Incorporated's New Bedford, Mass. plant

# Reliance Packaged Drives cut Modernization Cost 20%

Instead of one large motor-generator set, Revere Copper and Brass, Incorporated used five packaged V★S Drives to power the edger and tables on their rebuilt hot mill.

Reliance Drives package the M-G sets with controls and put them right at the mill itself. Conduit runs are of minimum length, which reduced not only material costs but construction time.

Control installation was vastly simplified. Each V★S Unit was prewired and pretested before shipping. The complete V★S Cabinets had only to be set in place and connected. Extra construction was not required for a generator room.

Packaged V★S Drives cut costs for Revere and gave more flexibility of operation and greater ease of maintenance. Reliance Packaged Drives will reduce drive installation and operating costs for any type of mill.

For complete details contact your Reliance representative, or write today for Bulletin No. D-2506. L-1586

**Product of the combined resources of Reliance Electric and Engineering Company and its Master and Reeves Divisions**

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IN STEEL MILLS

# WEIGHT LIFTING MADE EASY

Yuba designs and builds all types of custom steel cranes with lifting capacities of 5 to 1000 tons, for indoor or outdoor service.

**Yuba-Bedford Steel Mill Cranes are working to plant capacity —24 hours a day —year after year**

Two generations of steel makers have operated Bedford Cranes in mills from Pennsylvania to Peru. These are mills where the handling jobs are tough—where cranes work shift after shift under all conditions —and where there's time for only routine maintenance.

Hundreds of Bedford Cranes have been manufactured for leading steel producers...cranes that are specially designed and custom-built by Yuba to the tough requirements of the steel industry. Big lifting problems are made easy on every shift—for years!

Yuba designs, builds and erects all types of cranes including bridge, unloading and material handling, gantry and semi-gantry, floating and jib cranes. Also derricks, hoists and launching towers for defense ordnance.

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*specialists in steel mill cranes and custom cranes of all types*

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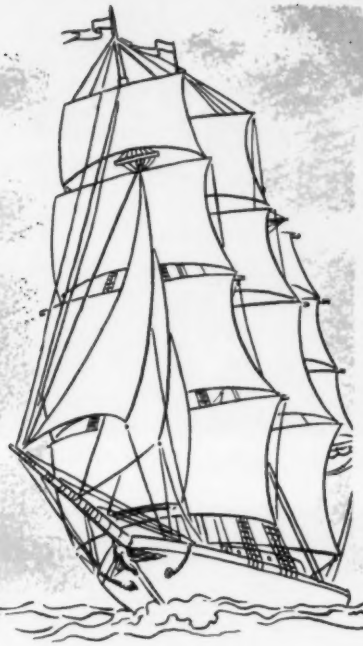
# Why Rust-Oleum is different—

*and what this difference, backed by 35 years of industry proof, means to you!*



*A Sea Captain developed it . . . Industry proved it!*

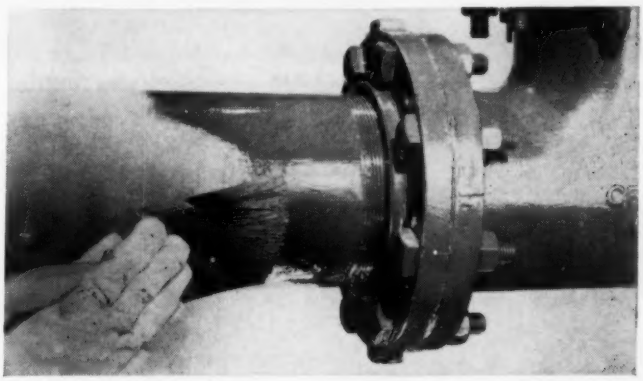
The original Rust-Oleum formula was developed nearly fifty years ago by Sea Captain Robert Fergusson, who became intrigued with the rust-stopping qualities of fish oil early in his career. Creating a *special treatment* for the fish oil, he used the *specially-processed fish oil* as the vehicle in combination with fine rust-inhibiting pigments. The result? A coating that actually *stopped rust* when applied directly over sound rusted surfaces, after scraping and wirebrushing to remove rust scale and loose rust. Possible, because the *specially-processed* fish oil penetrated the rust to bare metal. This was the birth of Rust-Oleum's *exclusive* 769 Damp-Proof Red Primer.

## PROVED THROUGHOUT INDUSTRY FOR OVER 35 YEARS

Today, Rust-Oleum in its many systems and colors, has been proved throughout industry for over thirty-five years. This proof by leading industrial users is your assurance of savings in time, money, and metal. Economies made possible by the fact that Rust-Oleum 769 Damp-Proof Red Primer goes right over the sound rusted metal—usually eliminating costly surface preparations. And Rust-Oleum, in its various systems, resists rain, sun, fumes, heat, weathering, chemicals, etc., for lasting beauty over the years.

## RUST-OLEUM NEW COLOR HORIZONS SYSTEM

The Rust-Oleum New Color Horizons System introduces a new coating concept to industry. It combines four important factors: (1) the ability to stop rust, (2) smart, modern color harmony, (3) the durability to last and last, (4) ease of application that saves time, money, and metal. See how this system can bring lasting beauty to your plant, machinery, equipment, pipes, tanks, structural steel, fences, etc. Write for complete information or contact your nearby Rust-Oleum Industrial Distributor. He maintains complete stocks for prompt service.



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There are imitations, but only *one* Rust-Oleum. It is distinctive as your own fingerprint.

## STOPS RUST!®

ATTACH TO YOUR LETTERHEAD

**Rust-Oleum Corporation**
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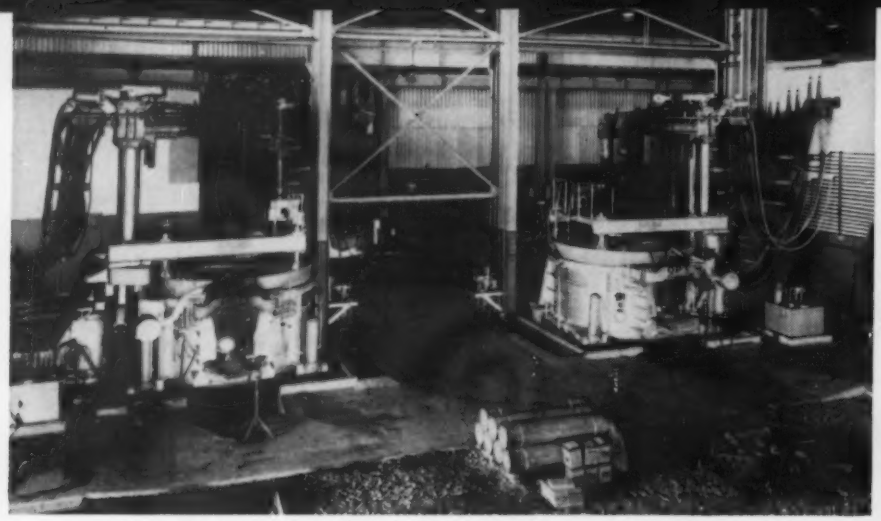
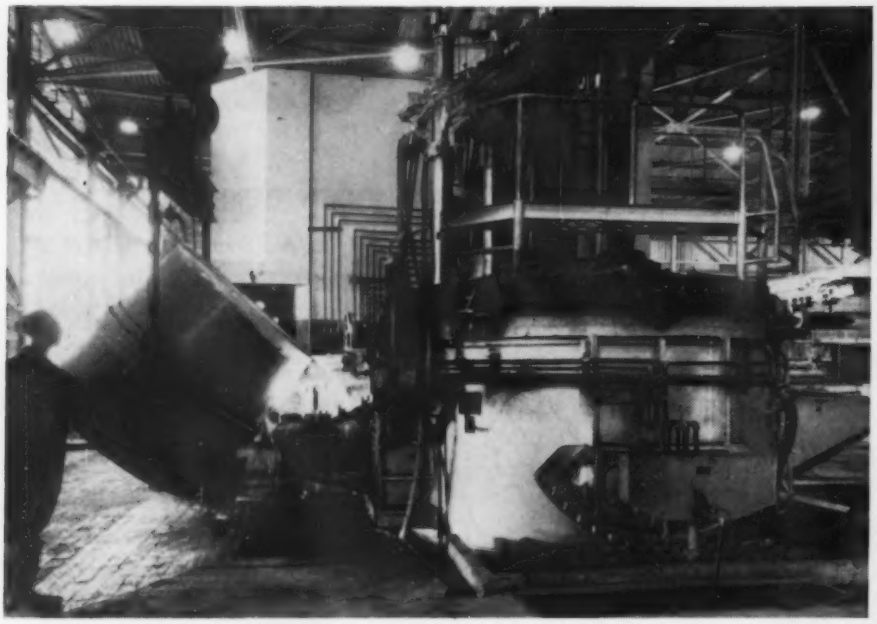
*Please send me the following at no cost or obligation:*

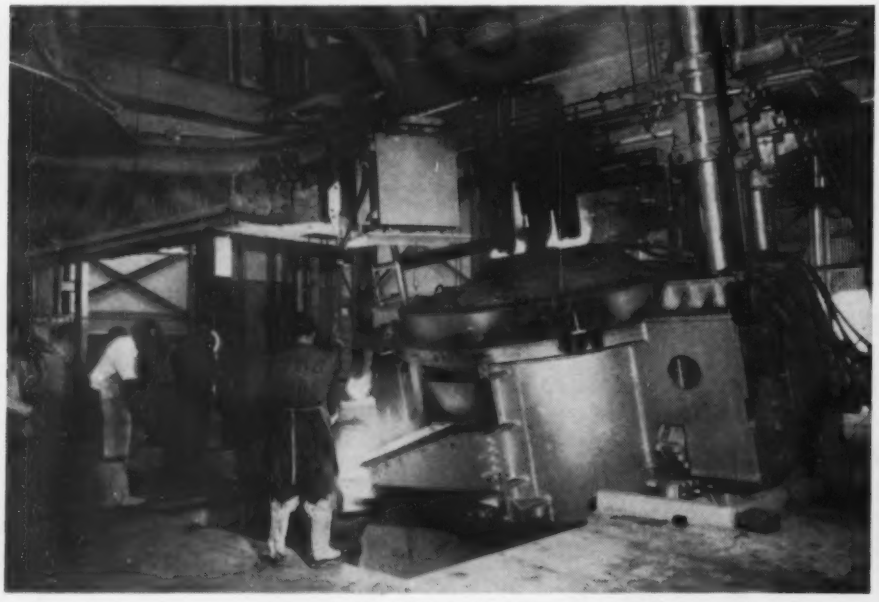
- ☐ New Color Horizons Systems Catalog featuring 110 actual color standards and 69 photo applications.
- ☐ Free test sample of Rust-Oleum 769 Damp-Proof Red Primer to be applied over sound rusted surface.
- ☐ Results of radioactive tracing study on Rust-Oleum fish oil penetration.



*Two Lectromelt cold-melt batch furnaces melt gray iron.*



*Molten metal is transferred to Lectromelt duplexing furnace through special duck-bill receiving spout.*



*Duplexing furnace is tapped into ladles which are conveyed to pouring floor.*

# Lectromelt furnaces in action

## *at Sao Paulo foundry*

Efficiency keynotes the layout of Lectromelt furnaces at this South American gray iron foundry. The two Lectromelt 5000-KVA cold-melt furnaces have fast charging, raise-and-swing roofs and superstructures. Each melts and taps in excess of 9 tons of iron in 1½ hours. The duplexing furnace, designed for fast handling of molten metal, superheats and adjusts the analysis of more than 20 tons of iron per hour.

For productivity in your melting, contact Lectromelt Furnace Division, McGraw-Edison Company, 310 32nd Street, Pittsburgh 30, Pa.

**WHEN YOU MELT... Lectromelt®** McGRAW EDISON

# Industrial Waste Treatment—Steel Plants

by MARION MORGAN, Assistant Chief Engineer,
Youngstown District Works, United States Steel Corp., Youngstown, Ohio

*. . . . proper sewerage treatment is important, and proper treatment together with minimum necessary flow can result in both space and maintenance economies . . . .*

AN integrated steel plant operation, such as is conducted by Ohio Works and McDonald Mills, poses four major waste treatment problems, even though we have no coke plant. These are sanitary sewage, waste pickle liquor, mill scale and blast furnace gas washer effluent. Waste treatment affects all operating departments, and becomes a major concern in plant design, capital investment and operating costs, not to mention space requirements. Waste treatment therefore must receive as much consideration as any other major factor in plant layout, equipment and process design.

It is not too serious a design problem, although expensive to incorporate the standard waste treatment methods, i.e., thickeners, settling basins, scale pits, etc., into the layout of entire new facilities, such as a new mill, a new blast furnace or for an entire new plant. You make maximum use of water taken from the stream, re-use it where possible, and after use, you are careful to keep clean water separate from contaminated water to minimize the volume of water to be treated and the size of necessary treatment facilities.

That is not the commonest problem—it is rather that of finding ways and means to improve the performance of old waste treatment equipment or to find space to install new equipment in old, crowded plants. Both Ohio Works and McDonald Mills take water from the Mahoning River, return it to the same stream and come under the jurisdiction of the Ohio Board of Health. These two plants, in common with other steel plants in Ohio, participate voluntarily in a permit system conducted by the State Board of Health involving more or less continuous reporting of the efficiency of operation of all our waste treatment facilities.

In what follows, it is necessary to have in mind a few facts about the Mahoning River, on whose banks are most of the large industrial plants at and near Youngstown. The river flow will commonly vary from a low of 120 mgd to a high of several billion gallons daily at different times of the year. At times of high flow, it will carry with it a vexing amount of leaves, trash and other debris to the detriment of intake screens, strainers and filters. The normal water requirements of several of the larger plants, including Ohio Works, is more than twice the low flow of the river, so that it is commonly believed that the entire river must flow through the equivalent of ten or more plants on its way through Youngstown. These plants are dependent upon the river, and considering that their monthly payroll plus goods and services purchased locally totals probably as much as $12,000,000 per month, the economic health of the community is in turn dependent upon the competitive position and prosperity of these same plants. The state regulatory agency has, so far, recognized these fundamental facts and has treated the Mahoning as an industrial stream, whose primary use is to serve the plants and through them the communities on its banks.

## SANITARY SEWAGE

Youngstown and other nearby cities and towns on the Mahoning are moving now toward installation of sewage treatment plants and within a period of three to five years, all will be treating sanitary sewage, although at present, untreated sewage is one of the major contaminants in the Mahoning River water. Local steel plants must now segregate sanitary sewage from other wastes and either build gravity sewers or in some cases, pumping stations and mains to deliver their sanitary sewage to the municipal systems for treatment.

Methods of financing municipal sewage treatment plants vary widely and are not subject to prediction either as to method or amount of cost. Generally, it is felt that a large industrial plant will be called upon to help pay for the sewage treatment facility in its community, in one way or another, so it might as well use the municipal treatment facilities rather than build its own. We expect to use city facilities both at Ohio Works (Youngstown) and McDonald Mills (McDonald Village).

For domestic and commercial establishments, the sewage treatment tax is generally a percentage of the billing for city water consumption, on the assumption that this is a fair measure of the cost of treating the sewage from each such establishment. Large industrial plants may use not only city water, but river water too, and in Youngstown, also the so-called "industrial water" from Ohio Water Service Co., which is relatively cool, relatively free of permanent hardness, but not potable, at only about half the cost of city water. Some of the uses of city water, such as cooling for critical bearings, for boiler feed water, air conditioning units, etc., does not affect the volume of sewage to be treated because the water is still clean after use and is discharged direct to the river via the mills own sewer system. The result is that the only definite means of determining the volume of sanitary sewage from such plants is metering the flow of sanitary sewage continuously.

Predicting in advance of actual metering the quantity of sanitary sewage from a large plant is not easy, but necessary to size the community treatment plant properly because in a small community, one plant may contribute a large percentage of the sewage to be treated, and the treatment plant must be of a size to serve all community needs for the expected life of the plant. Statistics are available to calculate the sanitary water requirements per employee, but in our experience, are generally misleading. We made extensive tests at McDonald Mills and now have a recording meter which registers the entire sanitary sewage flow from Ohio Works into the city's sewers. This meter confirms certain peculiarities of the flow established by the McDonald tests.

Figure 1 shows the normal flow is about 300,000 gpd with peaks of about 400,000 gpd at change of turn due to washing, etc. This is a seven-day chart, including Christmas week, during which we were virtually shut

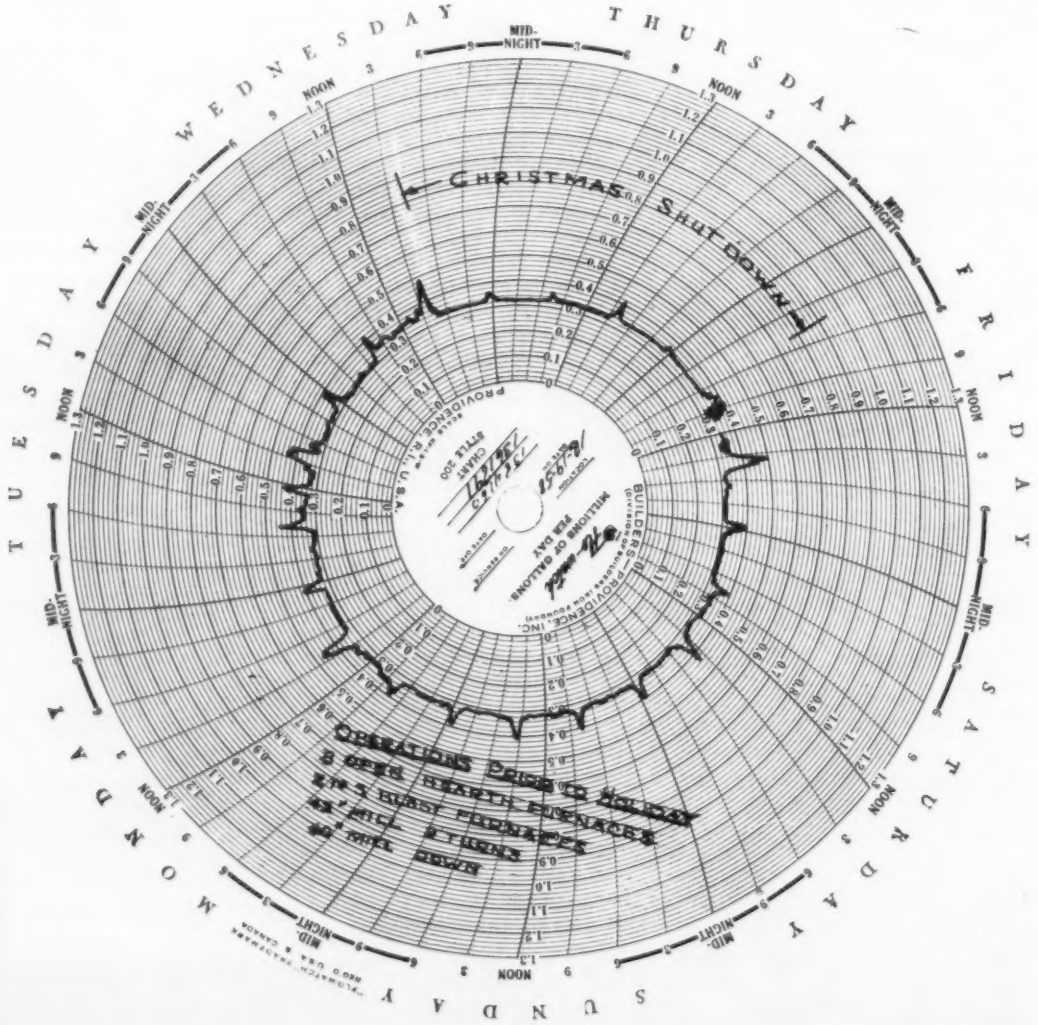



**Figure 1 — The chart indicates the amount of sanitary sewerage flow from Ohio Works. Note peaks at shift changes. Christmas shutdown had little effect.**

down for about 36 hr and had only about 15 per cent as many people in the plant as during the rest of the week. Note that the sanitary sewage flow was not appreciably reduced during this period, in spite of the 85 per cent reduction in people in the plant. Many drinking fountains, wash faucets, etc., were undoubtedly left running in severe weather, and we know that drains and other waste water connections are connected to the sanitary sewers as a matter of convenience over the years. These probably account for the phenomena. The cost of sewage treatment makes it worthwhile to correct this condition, but finding and correcting improper connections is very difficult and time-consuming.

In Figure 2 this same meter shows the effect of a heavy rain. The irregular oscillation of the chart is the result of the city sewers becoming overloaded, since they take much storm water in addition to sanitary sewage, and the flow backed up into and through our connections and meter. You will also observe that for the next 15 to 18 hr after the city sewer has cleared itself, infiltration of ground water into the plant sanitary sewers and the flow from drains and downspouts and other waste water connections maintains the flow ⅓ higher than normal.

## TREATMENT OF ACID PICKLE LIQUOR WASTE

U. S. Steel, as well as many other steel companies, participated in the experimental construction and test run of a pilot plant to try out the then most promising European process for complete treatment of acid pickle liquor. This process promised reasonably economical operation, and usable end products of iron oxide and rejuvenated full strength sulphuric acid, but the test results did not fulfill this promise. It became evident that to be at all economical, a plant using this, or similar processes, must be relatively large, that is, of a size that would serve most, if not all the steel plants in the immediate Youngstown district. This poses obvious new problems of joint financing, division of operating costs between companies, etc.

Fortunately other approaches to the problem began to appear recently which promise immediate results.

First, certain of our products at McDonald Mills lend themselves quite well to shot blasting as an alternate to pickling. Our first installation of shot blasting facilities promises to reduce our production of acid waste at McDonald by about 20 per cent.

Second, we operate normally, both a semi-continuous strip pickler and two batch picklers for sheets, bars, etc. Our semi-continuous pickler operates with rather high acid concentration and we find that the acid formerly discharged from it as waste, still retains sufficient strength to permit it being usefully employed in the batch picklers. This promises a further reduction of acid waste of almost equal amount, that is another 20 per cent.

Finally, experiments indicate that we may be able

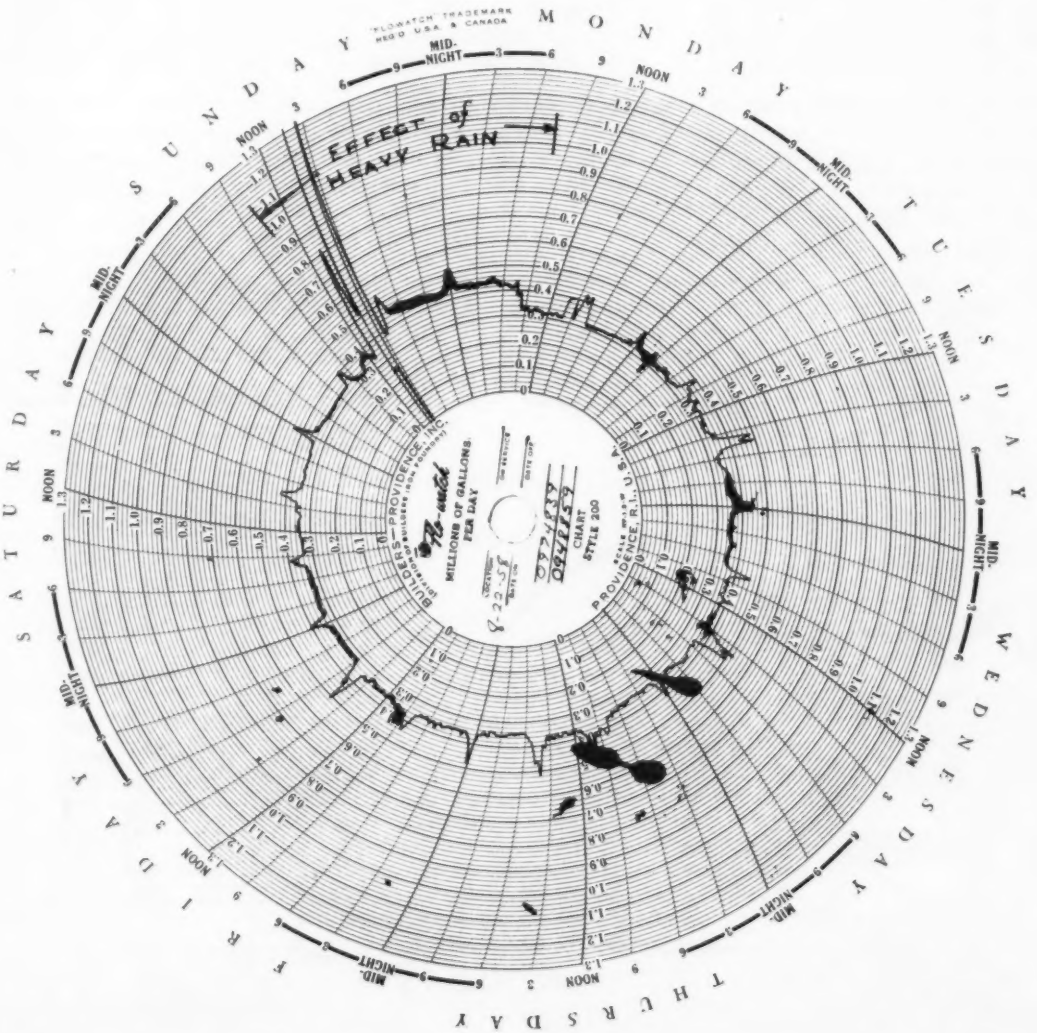



**Figure 2 — The effect of a heavy rain is indicated in the sewerage flow volume.**

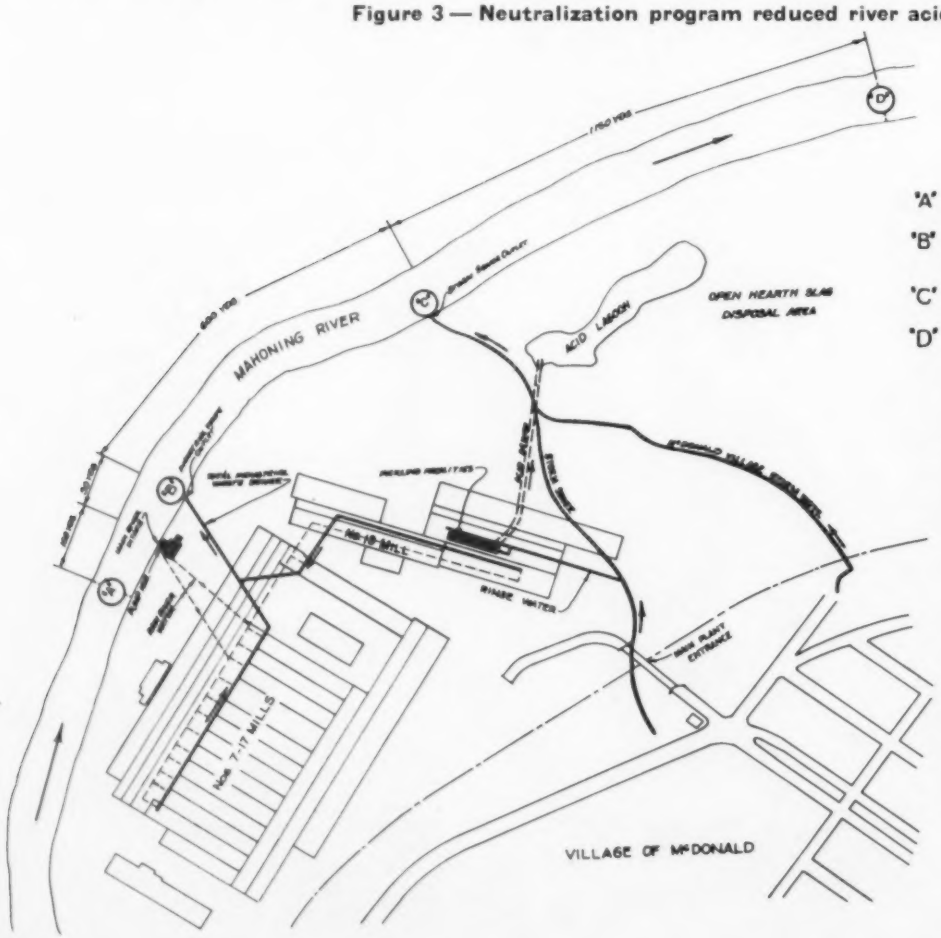
to do a very good job of neutrlizing acid waste at McDonald by lagooning such waste with open hearth slag fines. The acid waste from McDonald pickling operations has long been discharged via a 1200 ft brick-lined sewer to a lagoon on the upstream end of our principal slag dump. Originally, there was a treatment plant at the discharge end of this sewer, intended to mix milk of lime and acid waste and discharge the neutralized material into the dump. For various reasons, the plant was unsuccessful, but for a time the acid seepage from the lagoon formed below the old treatment plant was neutralized to a considerable extent by traveling several hundred ft through the slag before reaching the river. Examination recently indicated that channels had been cut through the slag bank underground so that the liquid delivered to the lagoon traveled more or less directly to either the river or to mill sewers in the vicinity and its composition and acidity were relatively unchanged. A temporary wooden extension to the acid sewer now carries the waste acid well beyond the present mill sewer, underground channels have been filled and a new bottom formed for the lagoon from a nearby pile of several million tons of open hearth slag fines from which most of the metallics have been removed by crushing and magnetic separation. Analysis shows that about one-third of this open hearth slag is CAO and MgO and in these sizes, is fairly active as a neutralizer of acid waste. This is indicated by laboratory tests and a series of actual tests of the river water above and below the lagoon.

The river test samples taken above (at "A") and below (at "D", Figure 3) the plant by cross sectioning the river from a rowboat, indicate that the net effect of our neutralization efforts was a slightly reduced acidity of the entire river, whereas we had previously added to this acidity in measurable amounts. The result on the first day (6/29/59) of our neutralization tests showed some need for improvement, and on subsequent days, that this improvement was possible. The effluent at "C" our storm sewer outlet includes a small amount of rinse water not neutralized, but in amounts far below the 15 per cent strong acid usage limit imposed by the Ohio Board of Health. Our testing of this operation was interrupted by the July 15, 1960, steel strike. Upon resumption of operations, it was planned to add slag fill from the nearby piles as required, to neutralize the discharge of acid bearing waste water into the new lagoon, and to establish means to assure control of the operation in the future. We believe this procedure offers good promise of reducing to suitable limits, the acidity added to the river from our McDonald Mills operations. It also offers a possibility that we can haul acid waste generated at the Ohio Works to this same lagoon for treatment.

## MILL SCALE

Ohio Works has two primary mills only, which make blooms, billets and slabs to be shipped to McDonald Mills for rolling to finished product. These Ohio Works mills are approximately 60 years of age. The scale pits in the original installation were very small and the tonnage now handled by these two mills is probably more than four times that originally planned, with a corresponding increase in water use. Space for an effective scale settlement system is completely lacking at the mills and the problem of tunneling under, around

**Figure 3 — Neutralization program reduced river acidity.**




'A' RIVER WATER SAMPLE - RIVER TRAVERSED AT THIS POINT TO OBTAIN RIVER WATER SAMPLE UPSTREAM OF RIVER PUMPHOUSE.

'B' INDUSTRIAL WASTE WATER OUTLET. - WASTE WATER INCLUDES: ALL WASTE SEEPAGE WATER, ALL SANITARY SEWAGE, AND THE BRINE PORTION OF THE STREAM WATER FROM THE MILL AREA.

'C' STORM SEWER OUTLET - STORM WATER INCLUDES: SMALL AMOUNT OF STORM WATER FROM P&B MILL, REMAINING STORM WATER FROM McDONALD VILLAGE

'D' RIVER WATER SAMPLE - RIVER TRAVERSED AT THIS POINT TO OBTAIN RIVER WATER SAMPLE DOWNSTREAM OF ALL PLANT WASTE WATER OUTLETS.

BEFORE NEUTRALIZATION PROGRAM

McDONALD MILLS
RIVER & WASTE WATER SAMPLES
ACID VALUES EXPRESSED IN TOTAL ACID AS CaCO3

| DATE | PPM 'A' | PPM 'B' | PPM 'C' | PPM 'D' |
|---|---|---|---|---|
| 4/27/59 | 36.0 | 20.0 | 998.0 | 50.0 |
| 5/4/59 | 23.0 | 11.0 | 329.0 | 27.0 |
| 5/6/59 | 19.0 | 7.0 | 13780.0 | 24.0 |
| 5/8/59 | 31.0 | 21.0 | 1314.0 | 29.0 |
| 5/11/59 | 34.0 | 16.0 | 899.0 | 30.0 |
| 5/15/59 | 29.0 | 9.0 | 1426.0 | 46.0 |
| AVG. | 29.0 | 14.0 | 3172.0 | 34.0 |

# HIGH READINGS DUE TO SEEPAGE FROM LAGOON, CORRECTED 6/28/59

AFTER NEUTRALIZATION PROGRAM

McDONALD MILLS
RIVER & WASTE WATER SAMPLES
ACID VALUES EXPRESSED IN TOTAL ACID AS CaCO3

| DATE | PPM 'A' | PPM 'B' | PPM 'C' | PPM 'D' |
|---|---|---|---|---|
| 6/29/59 | 20.0 | 6.0 | 649.0 | 24.0 |
| 6/30/59 | 29.0 | 7.0 | 300.0 | 26.0 |
| 7/6/59 | 20.0 | 4.0 | 2.0 | 16.0 |
| 7/7/59 | 15.0 | 2.0 | 50.0 | 15.0 |
| 7/8/59 | 21.0 | 6.0 | 920.0 | 19.0 |
| AVG. | 21.0 | 5.0 | 384.0 | 20.0 |

RIVER WATER SAMPLING
U.S. STEEL CORP.
McDONALD MILLS

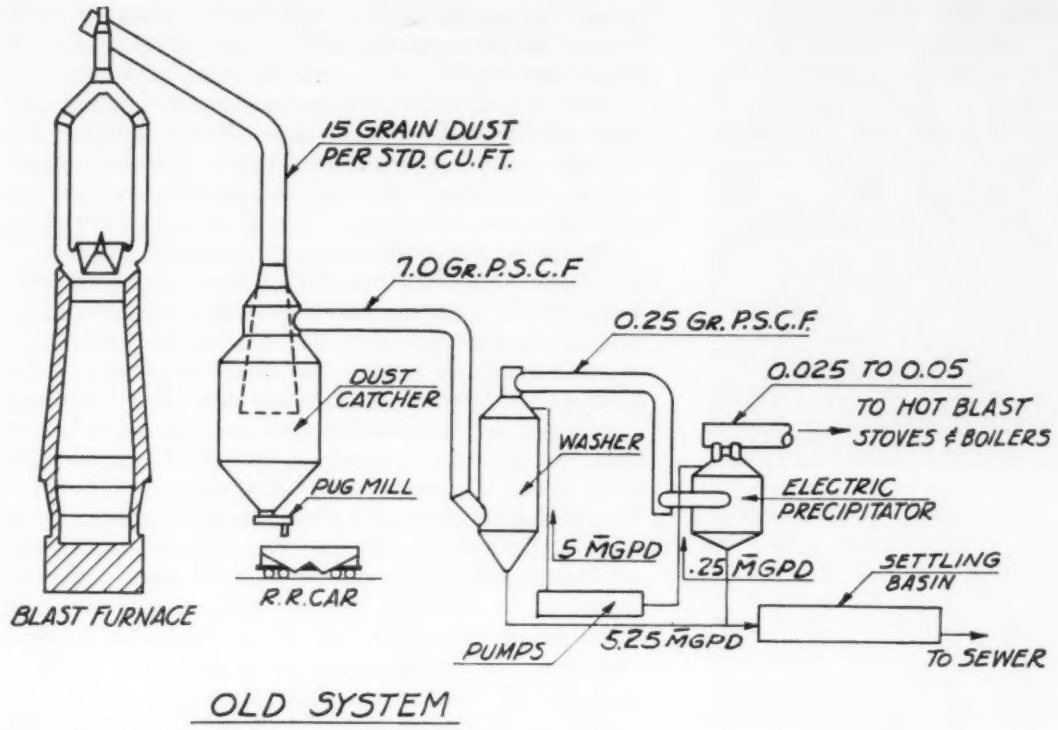



**Figure 4 — Typical older design blast furnace gas cleaning system uses tile gas washer and requires 5,250,000 gpd.**

and through the ancient brick and stone foundations and other underground workings is really formidable.

A new mill to replace the present two primary mills would be so different in layout, in water requirements and the like, as to make entirely useless any presently installed scale treatment facilities. Therefore, to avoid an expensive, unsatisfactory and short-lived scale treatment installation, we hope a new mill can come along within the time when we are required to put in additional treatment facilities.

Recent developments in scale handling include the effective use of dry scale conveyors under all tables of blooming and slabbing type mills, except at the mill stands proper, where roll cooling water wets the scale. This development should greatly reduce the amount of scale bearing water to be handled by scale pits, but is not applicable to old mills such as ours.

McDonald Mills was built largely during the period from 1917 to 1936 and has scale settlement sumps, but these are small for the present mill water consumption and tonnages, even though they capture more than 80 per cent of the scale produced. We will probably install additional scale treatment. At present, the design of scale pits has to include some sizable and important unknowns so that the prediction of performance of any given installation is far from an exact science. Areas of turbulence such as commonly occur at the entrance to the pit, tend to defeat the purpose of the entire installation. While baffle plates are sometimes used to advantage, they may be a great nuisance in interfering with scale removal. Methods of cleaning the

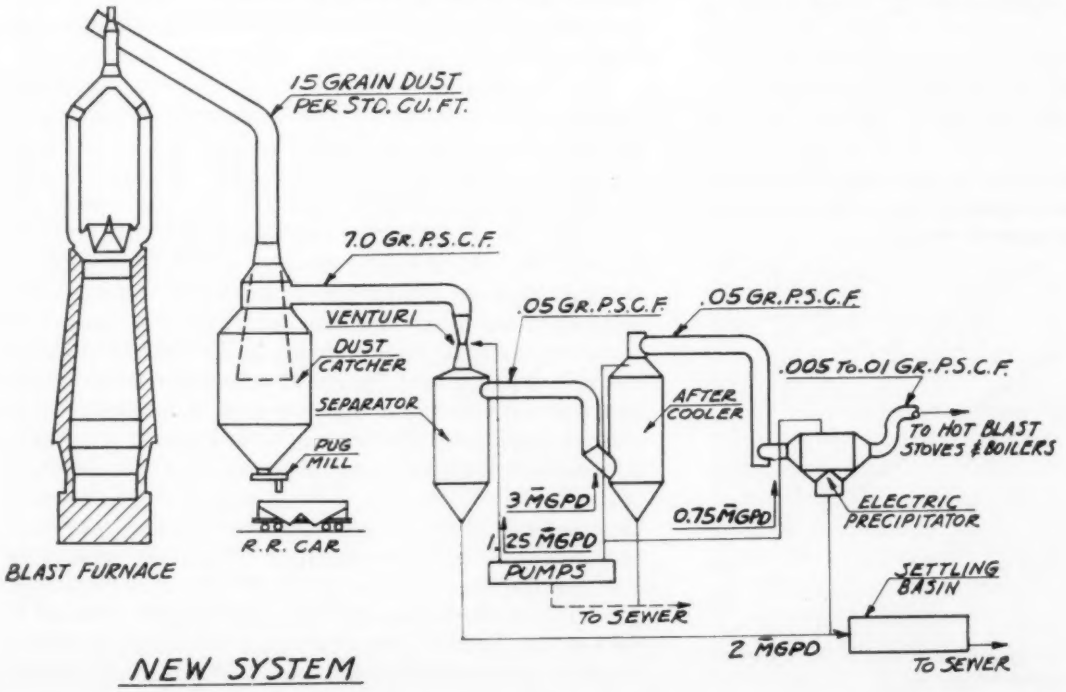



**Figure 5 — The use of a venturi permits a reduction of water requirements and results in cleaner gas supplies.**

pits are also only an approximation of what is wanted. Cleaning by bucket crane can remove a large part, but not all of the accumulated material because of the washing action as the partially filled bucket travels up through the liquid from the bottom. Continuous scale removal by drag conveyor has the advantage of keeping the entire pit clean and maintaining the maximum retention time for the best settling efficiency, but special attention must be given to the need to avoid the problems of breaking drag chains when the conveyor is stopped for any reason and the collected material accumulates. There is often rapid wear of moving parts in scale bearing waters and a drag chain installation must have a large factor of safety to handle large chunks of material such as come from blooming mills along with the usual smaller pieces of scale.

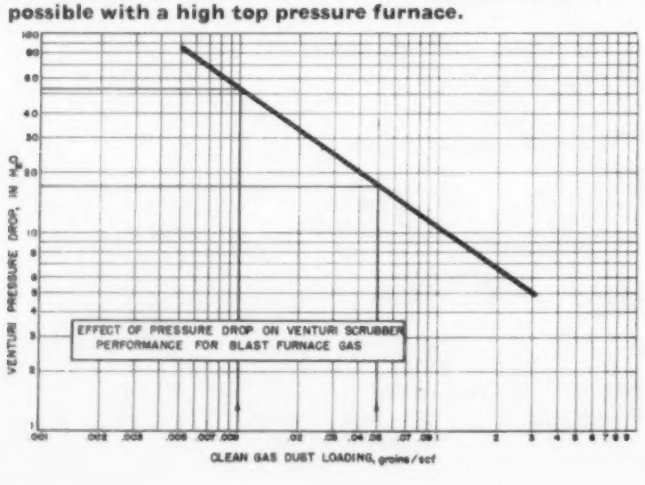
It might be of interest to add that Mellon Institute under the sponsorship of the American Iron and Steel Institute is presently conducting extensive experiments on the operation of scale pits with the purpose of providing good basic design information. This work includes both laboratory size models and actual field experiments in nearby plants. When the results are available this should permit us to come much closer to predicting the performance of any particular installation, and to getting the maximum benefits per dollar invested in scale collection facilities.

## BLAST FURNACE GAS WASHER EFFLUENT

About five years ago, we spent a sizable amount for engineering by well known outside consultants, and had them plan a gas washer effluent treatment system to serve our entire blast furnace installation. We thought the plan sound for the foreseeable future, and based upon what we knew then, it was. Advances in the art of making sinter and operating blast furnaces on beneficiated burden proved our assumption to be wrong fortunately, before the treatment system was installed. We had planned to install gravity sewers to take washer effluent from each of six furnaces to one point for treatment by thickeners and filters with a capacity of 30 mgd.

The use of sinter and screened ore will increase our blast furnace capacity by more than 20 per cent and reduce the number of blast furnaces needed. At the same time improvements in the art of cleaning blast furnace gas have greatly reduced the amount of dirty water per furnace to be treated (see Figure 4). The substitution of sinter and screened ore for run-of-the-mine ore in the furnace burden has both reduced the amount of dust to be removed by the gas washer, and apparently changed its character so that it settles out easier from the wash water. Therefore, we are currently re-examining the performance of the settling basins we now have, as a possible alternate to the large expenditures for the installation of thickeners, filters, etc.

**Figure 6 — The calibration curve of the venturi scrubber points out that greater reductions in dust loading will be possible with a high top pressure furnace.**


VENTURI PRESSURE DROP, IN H2O
EFFECT OF PRESSURE DROP ON VENTURI SCRUBBER PERFORMANCE FOR BLAST FURNACE GAS
CLEAN GAS DUST LOADING, grains/scf

To go further into this matter, let us look at Figure 4, a typical blast furnace gas cleaning system, as we built them a few years ago. Major items in the pictured installation are the standard dust catcher and following that, the primary washer of the wetted surface tile filled type. This primary wet washer used about 5 mgd of wash water and discharged the same amount of dirty water into the settling basin and cleaned the gas to about 0.25 grains per cu ft. It required constant attention to maintain its effectiveness and generally operated at something less than designed efficiency. Following this washer, there was a tube type electrical precipitator using about 250,000 gpd of water; discharging an equal amount of dirty water to the settling basin. With maximum and constant maintenance, the tube type electrical precipitator gave gas cleanliness of about 0.025 to 0.05 grains per cu ft. The total contaminated water to be handled at one such installation was about 5¼ mgd. Right now we have a large new sinter plant and are operating on 70 per cent sinter burden; and we find ourselves making changes to blast furnace practice and changes and additions to blast furnace auxiliaries to obtain good performance on beneficiated burden. Among other things, this involves increased hot blast temperatures, greater stove capacity, smaller stove checkers and much cleaner gas to the stoves—on the order of 0.01 grains per cu ft instead of 0.03 to 0.05 grains per cu ft. In equipping furnaces for this new burden, we employed the venturi washer instead of the tile, and also tried to improve the waste treatment situation. Recently at our No. 4 furnace, we put into service a gas washing installation as shown on Figure 5.

This installation (Figure 5) should be compared directly with Figure 4. The equipment shown is a venturi throat in the main leading from the dust catcher, having water nozzles at the throat, and discharging about 1,250,000 gpd into the gas stream at the point of turbulence. Directly below the venturi is a so-called dirty water separator which de-waters the gas and permits discharge of the wash water to the settling basin. Following the separator, gas goes into an after-cooler in which about 3,000,000 gpd of cool water is sprayed into the gas to reduce its temperature to a point where its volume is low enough to permit the existing gas mains to carry it to the boiler houses without excessive pressure drop, and preserve the volumetric efficiency of the boilers. The gas at this point has a cleanliness of about 0.05 grains per cu ft and goes then to a wet plate type precipitator. When the gas leaves the precipitator, it has about 0.005 to 0.01 grains per cu ft of dust. The precipitator, a plate type unit, uses about 750,000 gpd water and discharges an equal amount of contaminated water to the settling basin.

The effectiveness of the dirty water separator beneath the venturi throat is such that the water discharged from the after-cooler contains less than three grains of dust per gal, does not require treatment and may either be recirculated or discharged direct to the river. The total amount of contaminated water to be treated in the settling basin is about 2,000,000 gpd compared to 5,250,000 gpd with the old system shown on Figure 4. Because this lesser amount more than doubles the retention time in the settling basin, the efficiency of the settling basin is greatly increased. The improvement in settling basin efficiency has been startling to us and we are watching its performance with great interest, since it is currently doing about as well as the usual mechanical devices such as thickeners and filters.

Experience with the venturi type scrubber indicates a further improvement in blast furnace gas cleaning systems is possible and at this moment, appears it will be widely used.

Figure 6 shows the curve developed from tests and installation of venturi type scrubbers. This figure represents the apparent possibilities of the venturi scrubber with pressure drop across the venturi throat as ordinate and outlet gas cleanliness as abscissa. The installation shown on Figure 5 gives gas cleanliness leaving the venturi of 0.05 grains per cu ft. Reading up to the red line and then to the left to the pressure drop scale, we see we must design the throat for 18 in. of pressure drop at the design capacity. This is our actual experience, and so far, it works well. The manufacturer's guarantee was gas cleanliness of 0.05 grains per cu ft at 35-in. pressure drop. The actual was much better (0.02 grains per cu ft at 35-in. pressure drop) as represented by the curve (Figure 6).

Now, if we want to eliminate the precipitator entirely and get 0.01 grains per cu ft cleanliness leaving the venturi, we read up from this point to the heavy line and intersect it at about 50 in. pressure drop across the venturi throat. This may require some changes on the blast furnace top to equalize pressure in the space between bells when dumping, etc., but it now appears most furnaces will be operating with so-called high top pressure (10 to 15 psi) within the next five years. In that case, the 50-in. venturi pressure loss means nothing.

The benefits of eliminating the precipitator are many, aside from the obvious simplification of the system by eliminating one large and expensive item, its space requirements, installation and maintenance costs, its valving and by-pass piping.

Keeping the furnace and dust catcher the same, we consider in Figure 8 the three gas cleaning systems discussed so far. The so-called old system, consisting of primary tile washer plus tube type electrical precipitator—the new system consisting of 18 to 20-in. pressure drop venturi with separator and after-cooler, and plate type electrostatic precipitator, and the proposed system, a 50 to 52-in. pressure drop venturi with separator and after-cooler but no precipitator. The gas cleanliness indicates no loss of efficiency in the proposed system as compared to the present or new system. The water required shows some benefit by reason of having eliminated the water requirement for the precipitator in the proposed system, and, of course, you can recirculate 3,000,000 gpd from the cooler, if

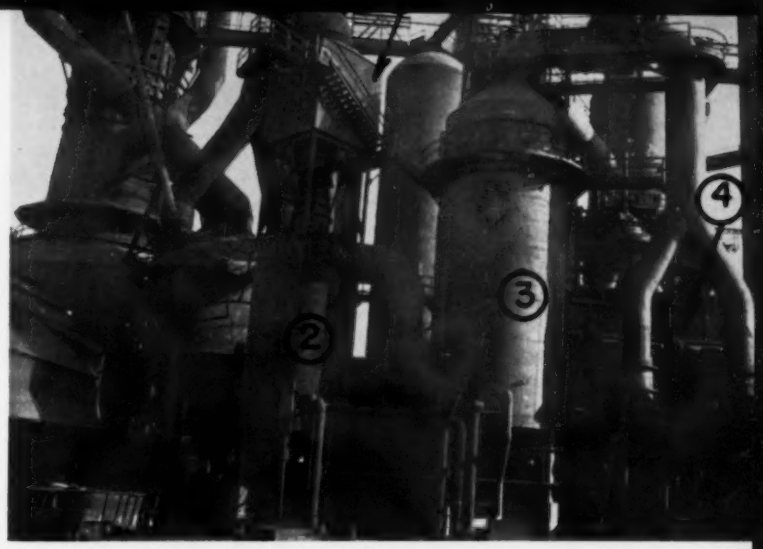


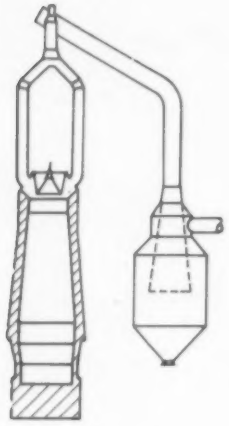

**Figure 7 — This venturi installation has: (1) venturi, (2) water separator, (3) gas cooler and (4) plate type precipitator.**

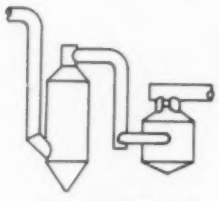
you need to. The major difference from the waste treatment standpoint is shown in the total contaminated water to be treated. The old system required treatment of 5,259,000 gpd; the present or new system requires 2,000,000 gpd and the proposed system 1,250,000 gpd. This feature promises further improvement in the performance of present settling basins, or alternatively, a sizable reduction in the size and cost of filter and thickeners to handle the effluent with mechanical equipment.

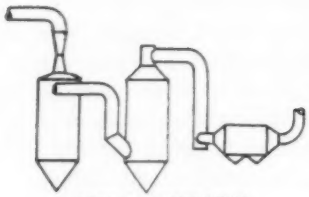
Now, let us look again at our plan of five years ago for gas washer effluent treatment and compare it with our present possibilities.

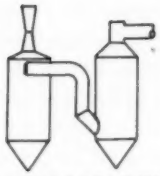
Then, we thought we needed a system to handle 30,000,000 gpd of contaminated water from six blast furnaces. Now, it seems reasonably certain for the same blast furnace production, we need operate only four furnaces and each of these will involve only about 2,000,000 gpd of contaminated wash water; so our treatment system need have a capacity of only 9,000,000 to 10,000,000 gpd. There is a strong probability we will never install another precipitator, but will use the high efficiency, high pressure drop venturi scrubber. If so, this will effect a further reduction in needed treatment capacity to 1,300,000 gpd times four furnaces or about 5,000,000 gpd. Finally, the combined effects of changing character of dust from sintered blast furnace burden and/or increased retention time in the settlement basin through reduced volume of contaminated water, promises great improvement in the collecting efficiency of present settlement basins. In fact, at the present venturi equipped furnace, the effluent from present settling basins is as clean as that from the average thickener installation, as shown in recent (January 1958) tests.

Had we proceeded with the original blast furnace waste treatment installation of the 30,000,000-gpd sewer, thickener and filter plant, we would now greatly regret it. Fortunately, we had, and used the opportunity to design new furnace auxiliaries to improve the waste treatment situation. We feel that similar, if not so spectacular improvements can be effected in treatment of almost any kind of waste, if it is taken seriously and done as a part of the layout and design of major facilities.









| | OLD SYSTEM | | NEW SYSTEM | | | PROPOSED SYSTEM | |
|---|---|---|---|---|---|---|---|
| | PRIMARY GAS WASHER | ELECTROSTATIC PRECIPITATOR | VENTURI & SEPARATOR | AFTER COOLER | ELECTROSTATIC PRECIPITATOR | VENTURI & SEPARATOR | AFTER COOLER |
| 1- DISCHARGE GAS DUST CONTENT- Gr. P.S.C.F | 0.25 | 0.025-0.05 | 0.05 | 0.05 | 0.005 To .01 | .01 | .01 |
| 2- PRESSURE DROP ACROSS UNIT- INCHES WATER COLUMN | 15" | 10" | 18" | | 8" | 50" | |
| 3- WATER REQ'D.- M.G.P.D. | 5.0 | 0.25 | 1.25 | 3.0 | 0.75 | 1.25 | 3.0 |
| 4- EFFLUENT To BE TREATED - M.G.P.D. | 5.0 | 0.25 | 1.25 | NONE | 0.75 | 1.25 | NONE |
| 5- TOTAL SYSTEM EFFLUENT BE TREATED - M.G.P.D. | 5.25 | | 2.0 | | | 1.25 | |
| 6- EFFLUENT SUITABLE FOR RECIRCULATION- M.G.P.D. WITHOUT TREATMENT | NONE | | 3.0 | | | 3.0 | |

**Figure 8 — A comparison of three systems shows that the venturi separator and after cooler combination will require treatment of only 1,250,000 gpd of water.**

## MAXIMUM USE OF RECIRCULATION

There is one other point, which concerns recirculation of water within a steel plant instead of taking more water from the river, using, treating it and returning it to the river.

For reasons previously stated, the Ohio waste treatment control authorities feel that the Mahoning River must be regarded chiefly as a source of industrial water, and that it is impractical to restore it to aesthetic beauty. We are going to have to treat our effluent to a degree consistent with the intended use of the river as an industrial water source, but the State can only prescribe a sort of common prescription for water treatment, which represents an average requirement for industrial water use. When so treated, it may not be ideal for any particular use. Therefore, if one has some particular uses for the water, instead of treating it to the common prescription established by the control authorities and returning it to the river, one should consider treating water one has already used, for one's own re-use. Ohio Works circulates about 290,000,000 gpd, but takes only about 120,000,000 gpd from the river, and makes up the difference by recirculation. Notice that this is approximately equal to the low flow of the river, so that we are relatively independent of fluctuations in river flow. As an example of re-use, river water in amounts of 60,000,000 to 80,000,000 gpd is pumped directly through surface condensers serving two condensing turbogenerators, then picked up and a major portion of it re-pumped for blast furnace stack cooling, again re-pumped for use in gas furnace blast washers while the remainder of the water from the turbogenerator condensers is re-pumped into the plant general service water system for use on mills, open hearth, etc. Approximately 50,000,000 gpd of daily water requirements are provided by chemical treatment and continuous recirculation over cooling towers of the condenser water for three turboblowers. This latter installation, made as an alternate to the installation of a new river water pumping station, and lengthy supply and discharge piping, has been markedly successful in that we have never needed to clean the condensers in seven years of operation, while similar condensers operating on river water must be cleaned bi-weekly. It is only fair to add, that so far we have not been able to justify economically, the installation of further cooling towers for the turbogenerator condenser water, even though these presently operate on river water.

In summary then, we believe that with recirculation, one can suit waste treatment exactly to needs for subsequent re-use. If, instead of treatment and re-use, one goes to the river for more water for other uses, one must accept the kind and degree of treatment prescribed by the control authorities for the average need of the district. Because of the wide fluctuation in the amount and type of water provided by the river at different seasons, and specially in time of high or low flow, one will often find river water less suited to the particular purpose than if one treated his own effluent for his own re-use. ▲

*Mill scale can be much more than a problem—its recovery can be economical.*

# Industrial Waste Control—Mill Scale

by DE YARMAN WALLACE,
Research Engineer, Chemistry,
The Youngstown Sheet and Tube Co.,
Youngstown, Ohio

UNTIL a few years ago, a principal reason for installing scale pits was to provide a collection basin that would prevent the sewer from becoming plugged. The control on the design of a scale pit was to make it large enough so that a clamshell bucket could be used for cleaning. Mill scale was just one of those problems one had to contend with in the operation of a steel mill. Mill scale recovery received real attention only when the water started to backup in the mill due to a full pit or plugged sewer. A common remedy was to use the fire hose to flush the sewer and the scale pit in order that the job of processing steel could continue.

Since the recovery of mill scale had received minor attention, the quantity lost was not realized. It was not until attention was called to this loss of mill scale by those in the industry that there was an awareness of such losses. On studying the possibility of reclaiming more mill scale, it was found, in some instances, that recovery of mill scale could be increased better than 50 per cent. This material could be returned to the process of making steel.

Recovered flue dust and mill scale represent iron units of value because they mean a reduction in the amount of ore purchased. Mill scale carries 70 units of iron, richer than any readily available ores. The market value to a company for the recovered mill scale is equal to the value of ore of equivalent iron content—at present, $14.50 a ton.

Scale is a valuable by-product in the processing of steel, just as is scrap. The scale may be recharged into the blast furnace or sometimes the open hearth, or it may be used in the production of sinter. The value of the steel when it reaches the hot rolling operation is high; therefore, it is reasonable to recover the scale just as the metallic scrap is reclaimed.

## SCALE PIT EFFECTIVENESS

As the mills have expanded and production has increased, scale pits have remained substantially the same. Utilizing these existing pits in such a way that they are most effective in the recovery of mill scale is the first objective. There are several possibilities for the majority of scale basins. True, some scale basins are just too small and should be replaced, but most pits can be made more effective.

*Efficiency of removal*—The usually accepted term of reference for performance is misleading when stated in terms of percentage. The impossibility of measuring the influent to a scale pit and even the effluent, unless the pit is properly baffled, makes it impossible to determine a meaningful percentage. The actual effectiveness of any settling facility is measured in terms of its ability to recover scale and to limit the particles in the effluent to sizes that will not settle in the receiving stream.

The gage of efficiency of recovery should be the weight of scale recovered plus the weight of material discharged to the stream. The gage of effectiveness in preventing damage to the diver should be the weight of material that will settle in the stream.

An effluent carrying predominantly fines might show a lower percentage efficiency of removal when passing through a given pit than would a waste carrying large particles. Yet, the effect on the stream might be less because the fines would tend to stay in suspension, while the heavier particles would tend to settle in the stream.

Scale recovery is a step in production. This idea is basic and important. Unless settling devices are so considered, their value will not be realized. If settling devices are so considered, then several possibilities suggest themselves:

1. More frequent cleaning of scale basins.
2. Proper baffling of the scale basin.
3. Dry scale removal and drag removal of large scale under the mills.

4. Bypassing of cooling water to reduce volume of water through the scale basin.
5. Redesign of scale collection system.

The possibilities of each of these methods will be discussed. The choice of the method to handle the scale recovery will depend on physical characteristics of the mill and on economics.

*More frequent cleaning of scale basins*—For maximum efficiency, the average scale pit, under normal operations, should be cleaned every two days or at least three times weekly. The blooming mill operations usually require daily cleaning. Unless kept clean, scale pits lose their effectiveness as settling basins.

Consider a scale basin 30 ft long, 15 ft wide, with an operating water depth of 10 ft. The flow of water through the pit is 5000 gpm (668 cfm). The settling of scale particles in the scale pit depends upon the terminal velocity (that is, the rate at which the scale particle would settle in quescent water) and the velocity of the flow through the pit. When the velocity of flow through the pit exceeds the terminal velocity, the scale will be carried through the pit. In our example, the calculated velocity through the scale pit, if clean, is 4.5 fpm. As the scale pit fills with settled scale, the cross-sectional area is decreased, and this increases the velocity of the water. Thus, if the pit is half full of scale, the velocity will be increased to 9 fpm and reduce the number of particles that would settle.

For scale pit efficiency, there should be sufficient retention time to allow the scale particles to settle out. In newer scale basin design practice, the required retention time to settle out coarse scale is considered to be about 20 min. The scale pit should be cleaned frequently to obtain maximum use.

Labor cost may be approximately a dollar per ton of scale recovered. The value of the recovered scale may adequately pay for the additional labor cost.

*Baffling of scale basins*—The objective of baffling a scale basin is to obtain proper distribution of flow and to control the velocity of flow. Model studies of scale basins and baffling would go a long way to answer many of the questions on how the present scale basins could be improved as well as aid in the design of new basins.

We have an example of what can be done by way of baffling scale basins. The Youngstown Sheet and Tube Co.'s merchant mill scale basin is 50 ft long, 10 ft wide with a working water depth of 7 ft. The scale basin lies in a north-south direction. The inflow to the scale basin is at the north end with the flow from the 12-in. mill on the west side and the flow from the 9-in. mill from the east side almost directly opposite each other. The total water flow is 5000 gpm (668 cfm). With no baffles or weirs in this scale pit, the scale recovery was about 300 tons per month. The effluent from the basin analyzed 230 ppm suspended solids, and the measured load to the sewer after correction for solids in the incoming water was computed to be 60 tons per month. The scale basin was originally cleaned weekly. After studying the operation, it was suggested that the scale basin be cleaned twice weekly. There was an improvement in scale recovery.

An experimental program was undertaken to determine if proper baffling of the scale pit would increase scale recovery. Experiments were made in the use of permanent magnets to try to flocculate the scale particles. Theoretically, due to increased size and weight, the flocculated scale particles should settle out faster.

A baffle was installed 14 ft from the north and just south of the influent water from the mills with a deflector on the downstream side to direct the solids to the bottom of the basin and distribute the flow evenly across the basin. Five feet north of the south end at the sewer outfall, a weir was installed which raised the water level in the scale basin to eight ft and also assisted in controlling the flow pattern.

The baffle arrangement was such that the coarse scale collected in the first section where the influents from the 9-in. and 12-in. mills entered. It was found necessary to clean this section daily to keep the water from backing up into the mill. The fine scale and some coarse scale, which did not settle in the first section, passed through four pairs of permanent magnets about five in. apart into the second settling basin.

It was found necessary to clean the second basin at least every two days. The material in this section was fine and required a tight clamshell bucket to remove it from the scale basin.

The increased recovery of scale was very striking. Instead of the 300 tons per month previously recovered, better than 500 tons per month were now recovered under normal operation. This was more than half again as much scale as was formerly recovered. The magnets were then removed and the study repeated with only the baffle and weir in place. Amazingly, substantially the same increased recovery was obtained.

The magnets did aid in increasing the particle size, but it was not sufficient to cause them to settle out at the velocity and volume of water which flowed through this scale basin.

The merchant mill scale pit, with proper baffling and the ability to obtain representative samples of the effluent due to the baffling, is now recovering better than 500 tons of scale per month under normal operation. The scale loss reduced from supposedly 60 to 30 tons per month obviously could not account for the 200 tons of increased scale recovery. The explanation lies in our previous inability to obtain representative samples from a scale basin as long as there was no controlled velocity pattern. The larger scale particles in an uncontrolled scale basin ride along the bottom and are not picked up by the sampling equipment. They went on to the river without our being aware of it. With the pit baffled, the large scale was recovered in the first section, the finer scale in the second section; thereby providing a control over the velocity flow pattern and samples representative of the effluent are now obtained.

The additional labor cost of daily cleaning amounted to less than $1.00 per ton of recovered scale; thus, the net value of the additional scale recovered is $13.50 to the company.

We have not only recovered a valuable material but reduced the loss of scale, an example of industrial waste control.

This experience is confirmed by others. Several companies which have established a closed system on their scale basins have thereafter recovered more scale than had previously been accounted for in the system.

*Dry scale removal and drag removal of large scale from under the mills and at the furnaces*—For maximum recovery, wherever possible, scale should be collected

and handled dry. There are operations where the scale drops off under the tables or transfer rolls. Furnace scale is an excellent example. Instead of flushing this dry scale into a scale pit or wheelbarrowing it to a manhole to add to an already overloaded scale pit, it can be recovered dry. This is probably the least expensive method of handling scale and provides clean, dry scale.

Several companies are installing drag equipment under the hot rolling mills to drag the scale out from under the mill. Without the need for water to flush scale, there is a material reduction in the volume of water a scale basin has to handle. With a reduction of water, the scale basin can separate and collect more scale; also, it saves water and reduces pumping cost. It saves having labor under the mill to drag the heavy scale into the scale basin.

There has been opposition to drag equipment because of a fear of breakdown and maintenance. However, when the drag equipment is properly designed for the job and operated in the proper manner, objections disappear. Actual experience in such situations has shown that the operators would not want to be without this equipment.

*Divert cooling waters from scale basins*—In most mill operations, the easiest place to dispose of cooling waters is to the scale pit. However, this additional water increases the velocity through the scale pit and materially reduces the scale recovery. Bypassing clean cooling water would make the scale pit substantially more effective by decreasing velocity and increasing detention time.

*New scale pit design*—When new scale basins are required, considerable thought should be given to the design to provide maximum scale recovery and most effective use of water.

The efficiency of removal of solids depends on the hydraulic characteristics of the settling basin—velocity of flow, turbulence, short-circuiting of the flow through the unit—and on the physical characteristics of the particles to be removed—size, shape, density and distribution in the liquid.

Essential to the effective design of settling facilities is an understanding of elementary hydraulic principles and forces acting on the settling particles. The design merits the best engineering consideration if it is to have maximum effectiveness.

### INDUSTRIAL WASTE CONTROL OF MILL SCALE

1. Mill scale represents iron units, and recovery means money.

2. If the scale pit removes the material that would settle in a river, then the second objective is accomplished—that of industrial waste control.

Mill scale can plug sewers and it can necessitate dredging to keep the stream navigable. Where intakes are located below the sewer outfalls, mill scale is carried into the intake and causes plugging of cooling systems and expensive maintenance problems. Recovery of mill scale thus has, possibly, additional benefits.

The objective of the pollution control agencies is to obtain substantially complete removal of settleable solids and floating material so as to prevent nuisance conditions and sludge deposits in the stream. This objective is translated into a requirement of industrial waste control. The steel industry has a second objective: recovery of mill scale for its value in iron units and dollars.

Accomplishment of these objectives requires evaluation of the effectiveness of existing scale recovery facilities, modification of facilities where feasible, proper design of new facilities and, most importantly, a constant surveillance of the frequency of scale pit cleaning. ▲

**Revised and rearranged collection of articles which appeared in the Iron and Steel Engineer between 1943 and 1950 . . . a book for rolling mill men and for anyone interested in rolling mills and roll design . . . written from a practical viewpoint by one who has had considerable experience in the art of roll design.**

# ROLL DESIGN and MILL LAYOUT

By **ROSS E. BEYNON**

**Price: To AISE Members . . . $3.00**
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**ASSOCIATION OF IRON AND STEEL ENGINEERS**

**1010 Empire Building** **Pittsburgh 22, Pa.**

# Closed Circuit Television

# For Industrial Applications

by E. C. CARROLL,
DuBois Engineering and Manufacturing Corp.,
Hammond, Ind.

*. . . . industrial television—still in its infancy—has with an increasing multitude of applications demonstrated methods of observation, control and training which are universally useful. . . .*

THE steel industry, like water, cannot stand still without stagnation. Every new idea or new product must be immediately scrutinized, analyzed, compared and tested for evaluation in its allied fields. It is not surprising that the radical ideas of today evolve so rapidly into standard procedures of tomorrow.

The glamorous and spectacular rise of commercial television, broadcast entirely for entertainment or cultural purposes, has hidden the development of a form of television which may readily outgrow its more popular sister. Industrial television was invisioned by television pioneers as the most promising form of television, and only in the past few years has there been an indication that they may be right.

Industrial television may be best defined in a negative sense as any form of television which is not broadcast for commercial use. As such it is transmitted over private channels for use by a selected audience viewing a specific scene. This paper will further restrict the definition of industrial television to industrial uses alone excluding such television as may be found in the fields of education and medicine.

The purpose of this paper is to examine the present status of television in the steel industry by reviewing some of the applications now in use. We will not go into detail on these applications nor will we try to explain the interworking of television but will endeavor to cover a number of applications.

We will point out how the steel industry can use a device which will provide an immediate picture of almost anything, over almost any distance, under conditions which would normally be inaccessible to the human eye because of danger, distance or severe physical conditions. Much of the answer lies in the many industrial applications which have come into use since the first industrial television equipment was assigned to the task of observing boiler gages in 1946.

In almost every early application, the advantages of industrial television over other means were discovered by the particular industry faced with an extended vision problem. The boiler gage is a good example of an extended vision problem whose solution reduced an industrial hazard.

To the pioneers of industrial television fell primarily

the task of meeting the specifications requested by industry as the latter found a rapidly expanding list of essential applications. This rapid growth of television did not continue until, as the term essential application implies, industry gained sufficient confidence in television to find for it applications other than those involving conditions hazardous to human life. Essential applications such as observations of nuclear processes were followed by cost-reduction applications such as materials handling control, and even luxury applications such as shopping by television. A further stimulus to a wider use of industrial television was provided by the television engineers whose contact with other industries provided a channel of experience between related industries and processes.

Many television applications are available for study and many more remain to be developed. We cannot predict all the possible industrial applications and may never be able to do so until we have become familiar with every process and every problem of every industry.

To simplify this task, we have put television application into two general classifications: requirements, and known uses. Classification by requirements has been listed by one television manufacturer as whenever it is too dangerous, to difficult, too expensive, too inconvenient, too inaccessible, too tiring, too far, too hot, too cold, too high, too low, too dark or too small to observe directly."

This list of "toos" can be further consolidated to observation of inaccessible subjects, dangerous observation, immediate transmission of information, reduction of cost, increased yield and expansion of the audience which is interested in a given observation.

Classification by known uses will be discussed in this paper by specific application in the steel industry.

## MATERIAL HANDLING CONTROL

Industrial television has provided many answers to problems of material handling control in steel mills particularly where the problems concern manpower conservation, observation under difficult conditions or the rapid co-ordination of information obtained from several points. Frequently a single industrial television system will solve all three problems at a given installation.

Manpower conservation is usually achieved by eliminating spotters or checkers who are stationed at points along the path of material flow and who position the material or control its movement over some limited range. In some cases the spotters or checkers observe the material flow and signal a central operator on its disposition. Here the co-ordination between the operators and one or more spotters is quite important. Industrial television eliminates this problem by providing the operator with a continuous and instaneous picture of the material flow.

Observation over the entire course of a given material in process may often require that the observer be stationed in some hazardous or uncomfortable area. Industrial television provides a ready answer to this problem.

One of the many applications of industrial television on material handling in the steel industry is in a large plant in Pennsylvania. Steel scrap from the fabrication departments is brought to a baling press and formed into 800-lb bales. The bales are conveyed over 300 ft to a railway siding and dropped into a gondola car. Approximately eight gondolas are filled each day. This entire process is controlled by the press operator with the aid of a single industrial television camera and monitor. After loading, the gondola car is removed and replaced with an empty one, all by the same operator who need not leave his station at the baling press.

A similar application was found in a midwest steel mill on their crop handling. With a television receiver mounted in the crop shear pulpit and a camera outside viewing the crop conveyor discharge, the shearman is able to control car loading without the assistance of a man outside.

At a roller bearing company in Ohio, industrial television is used to provide central control over the flow of steel tubes through both furnace and mill. The control room is located so that the operator is given a good view of the entire mill operation. However, this position is 80 ft from the automatic furnace. Often steel tubes, moving into the furnace conveyor at high speed pile into a "log jam" before a spotter can hand signal the operator. Production is stopped until the spotter can unscramble the tubes. An industrial television camera viewing the furnace, eliminates the spotter and gives the central operator an immediate indication of pending "log jams," thus providing increased production while freeing one man for more productive use.

In another application an industrial television chain is used to monitor the flow of molten metal in a continuous billet operation. The television camera gives a view of the mold entrance to the operator who formerly relied on hand signals from an assistant. In this application, industrial television eliminated the errors resulting from hand-signal communication. In addition, the hazardous and uncomfortable working conditions of the assistant's job were also eliminated. Television cannot give a false reading or indication. Television relays just what it sees.

In a sheet strip mill in Indiana, industrial television is used to monitor the processing of rolled steel strip. The 80-in. strip moves from a finishing stand across a 400 ft runout table to a coiler. A good view of the strip motion is limited both by distance and by the steam generated from water sprays directed on the cherry-red steel strip. Observation of the strip is extremely important since a false movement of the strip could result in a cobble or pile up and an average production loss of fifteen min. This is equivalent to a production loss of 120 tons of steel.

In this application the camera is mounted 40 ft above the runout table. The monitor is mounted at the control desk near one end of the table. A complete view of the steel strip is available to the operator at all times.

Here again the material handling control provided by industrial television results in reduced labor cost and an increase in production or yield.

## SINTERING MACHINES

Industrial television is now being used on several sintering machines, and many mills have specified television for future machines. A dust-tight camera is

located at the discharge end of the machine viewing the sinter on the last pallet. The monitor, in its dust-tight case, is located in the control panel at the feed end of the line.

With the camera and monitor in these positions the sinter is inspected as it approaches and just before it drops into the discharge chute. This continuous inspection of the end product is performed at the control station at the feed end of the machine where the monitor is located. With the various controls located at the control station, the operator is able to make any adjustments necessary to produce the best possible sinter which will deliver the greatest yield.

Prior to using industrial television the operator was required to leave his control station, walk the entire length of the line and inspect the sinter. This inspection was made at the discharge end of the machine where the television camera will be mounted.

If, under the latter inspection method, the operator noted an adjustment had to be made, he would return to the feed end and make the necessary adjustments. This would necessitate another trip to the discharge end to observe the results of his adjustments.

Another application for industrial television in a sintering plant is to observe the cooling tower to insure even loading.

The camera is positioned to view the cooling tower with the monitor located at the operators control station. The cooling tower could be viewed on the same monitor as is used for the sintering line.

Through this system, the operator can watch the cooling tower loading and increase or decrease the speed of its rotation for even loading. Again, all adjustments can be made without leaving his station at the feed end.

Prior to industrial television, as in the former instance, this information was available only by leaving the control station, walking the full length of the line and looking out at the cooling tower from a position where the television camera could be located.

These two jobs can be done with only one monitor and a switcher or done separately.

## SLAB REHEATING FURNACES

Many mills are now using television on their slab reheating furnaces both on the entry end and on the discharge end. By locating a television camera on the entry end of the furnaces, one operator can push as many as six furnaces, four by television and two directly. This eliminates two operators or spotters per turn and two pulpits. Television is utilized at the discharge end of the furnace by mounting cameras in the furnace wall near the discharge chute. The pusher operator is able to see the slabs on his monitor and know when a slab has been delivered. Prior to using television the operator had to guess or rely on past experience to know when he had pushed far enough to deliver a slab. Many times the slabs were pushed too far so that the leading edge of the next slab was out of the furnace causing uneven heating and trouble rolling.

Industrial television eliminated the spotters, the danger of expensive furnace damage and has increased yield. Industrial television particularly in material handling control application, also eliminates split responsibility between spotters and operators. In case of an accident or extensive equipment damage, there is no question as to who was responsible.

## VISUAL TRAINING

The importance of properly training industrial workers, was clearly shown during World War II. Millions of totally inexperienced people had to be transformed into proficient workers on limited but essential tasks. It was found that few workers could be expected to produce most efficiently if they were allowed to select or devise their own methods of performing the work. However, production rapidly increased when the task was standardized to the best possible techniques and each worker was required to follow these techniques. Whenever the task was changed complete retraining was usually required.

The lessons learned in World War II were applied with excellent results to the period of reconversion to civilian production. The growth of labor unions and their strict seniority policies placed further emphasis on the importance of industrial training. The inefficient worker could not be indiscriminately released.

The training methods available to industry included instructions by fellow workers on the same job, classroom instruction in a separate training area and training films. Each of these methods has been found wanting to some extent. Instruction by fellow workers disrupts their production and passes onto the new worker the nonstandard "tricks-of-the-trade" which they have failed to overcome. Further, a good worker is not necessarily a good instructor. The classroom method too often fails to reproduce adequately conditions as they actually exist in the plant. The use of charts and drawings is not effective with persons who normally obtain little information in this manner. Watching a demonstration from the back of a classroom is equally ineffective.

Training films overcome many of the limitations of the fellow-worker and classroom methods. The special devices center of the Office of Naval Research has made a very thorough study of industrial films as training media. This study, under the direction of Professor Robert T. Rock of Fordham University, has shown that the very polish of training films tends to detract from the subject to be mastered. The production of training films has been left to the professionals because of the skill involved. The Hollywood movie techniques of fade-outs, background music and even nonessential color have been shown to be distracting. It is generally agreed that training films do not provide the immediacy of a television presentation. A survey was made among surgeons to determine their preference between color films and color television for surgery instruction, and 85 per cent of the surgeons polled said they preferred industrial television. A slight majority said they would rather watch an operation on industrial television than standing next to the surgeon at the operating table.

The army has made a similar study which included a comparison between direct demonstrations of detailed tasks (such as rifle disassembly) and presentation of the identical task with television closeups. The direct demonstration was found to be less effective.

One of the major advantages of industrial television

on training applications is that a training presentation is available as soon as a single operator has mastered the new machine or new techniques. There need be no long delay awaiting training films or other material. Further, the operator whose skill is being followed on the television screen is recognized as a fellow worker actually doing the job under conditions which will be encountered by the trainee.

## SECURITY AND LAW ENFORCEMENT

Applications of industrial television to industry are primarily concerned with plant protection. As such they supplement the plant guard force and permit a direct reduction in overhead cost. Each television chain multiplies the vision of a centralized guard headquarters. Where the theft of company products or facilities becomes a serious problem, television cameras can be put in the areas under suspicion and the wrong doers apprehended. On outdoor applications a weatherproof camera housing is essential. Where the scene is fixed and not artificially lighted, a remote iris control can be used to permit adjustment for the wide range of daylight. Where the scene consists of a large area, a remote pan and tilt mechanism as well as remote optical focus control can be used.

One of the leadlng steel mills in the east has engineered and designed a method of remote controlling a gate by use of industrial television.

An alarm is tripped by the vehicle approaching the gate, calling a guard's attention (in central guard headquarters) to his monitor. If the vehcile is recognized, he opens the gate from his position at the monitor. Should there be a question about the vehicle or its passengers the guard can talk to the driver by radio. They feel it will be necessary to have a guard at the gate only at shift changes.

A midwest oil refinery is also using television on one of its plant gates. This gate is manned on the day shift only (due to truck traffic). At 5:00 PM this gate is closed to all truck traffic and television takes over. Any plant personnel wishing to enter or leave the plant by this gate after 5:00 PM must go to the room where two television cameras are located, dial guard headquarters on the plant phone system, hold his identification in front of one camera while facing the other camera. The guard headquarters can compare the employee's picture (on his identification card) on one monitor and the employee on the other monitor. If the employee is properly identified, the gate is opened from the guard's position at the monitors. If there is a question, the guard can talk to the employee on the phone or send a guard to the gate.

## UNDERWATER APPLICATIONS

Industrial television often provides an inexpensive substitute for the diver. In addition it permits observation of areas which are inaccessible to the diver, and gives a view of these areas to an expanded audience.

Areas inaccessible to a diver are not only the great depth of the ocean but the important steel mill harbor areas and intakes which often have swift tidal currents.

Expanding the audience which can observe the underwater work, permits experts in many fields to offer assistance. The expanded audience also increases the safety of the diver.

## SHEAR APPLICATIONS

Industrial television today is finding important application on shear lines and is being used primarily for:

1. Checking material length before shearing.
2. Checking shear bed to be sure it is clear before next pass.
3. Both of the preceding items.
4. Inspection of material after shearing—for pipe.

These jobs can be done in many ways—everyone seems to have his own way of doing it. The most common way is to mount a camera on a pan and tilt mechanism on a wall adjacent to the mill and in the center of area to be covered. A scale is placed on the guard rail of the runout table, and the monitor in the shear pulpit. This setup enables the shearman to know the length of material before shearing.

On the second application a camera, usually in a water-cooled housing, is located near the table looking at the shear bed to indicate to the operator that the previous crop has cleared.

Usually both installations are used depending on what the shearman can see from his pulpit.

The camera looking at the shear bed can also double to inspect the slabs to be sure all the pipe has been sheared out.

We engineered a shear application where the camera would be mounted vertically 70 ft above the mill looking down at the material to be sheared. A center line was etched on the vidicon tube so that it would appear on the monitor. The shearman was given a key board where he could punch material length. This would train the camera above the mill to a relative position to the material length. The etched line would then appear on the monitor viewing end of the material to be sheared indicating to the shearman that he could or could not shear out the desired 15 per cent from the front end and still be able to deliver the desired length to the mill. It was also necessary to compensate, electronically, for thicknesses from 6 to 12 in.

## SUMMARY

The applications that have been discussed are representative of some of the more common industrial uses which have been found for industrial television equipment, undoubtedly many other applications exist.

When purchasing closed circuit television it is important to remember it is to be used in a steel mill. Specify and insist on heavy duty steel mill type television equipment. There is nothing harder to do than try to make cheap, light-duty, commercial type equipment do a steel mill job. Then maintenance on light duty equipment will be greatly increased as well as downtime. One installation of this type and all closed circuit television will be written off as impractical for steel mill use while competition continues to utilize this time and money saving tool.

Television has found a firm footing on the path of industry's endless quest for improved service and production. Apply it properly. ▲

# Expansion of Electrolytic Tinning Facilities at Pittsburg Works

*Special design features have provided safer working conditions, improved quality, lowered maintenance and minimized investment costs at Pittsburg works No. 3 tinning line.*

by T. B. BRUCE,
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THE first facilities for producing electrolytic tinplate on the West Coast were installed at the Pittsburg Works in 1948. Since that time these facilities have expanded progressively to meet the growing demand for tinplate by the western can making industry. The first major expansion was completed in 1952 and, in 1958, a third electrolytic tinning line was added which started production in March, 1958.

Figure 1 illustrates present tinplate producing facilities and the product flow between the different units. The processing begins with hot rolled coils that have been shipped by rail from the Geneva Works near Provo, Utah. Tinplate facilities, in order of coil processing sequence, include two continuous picklers, a

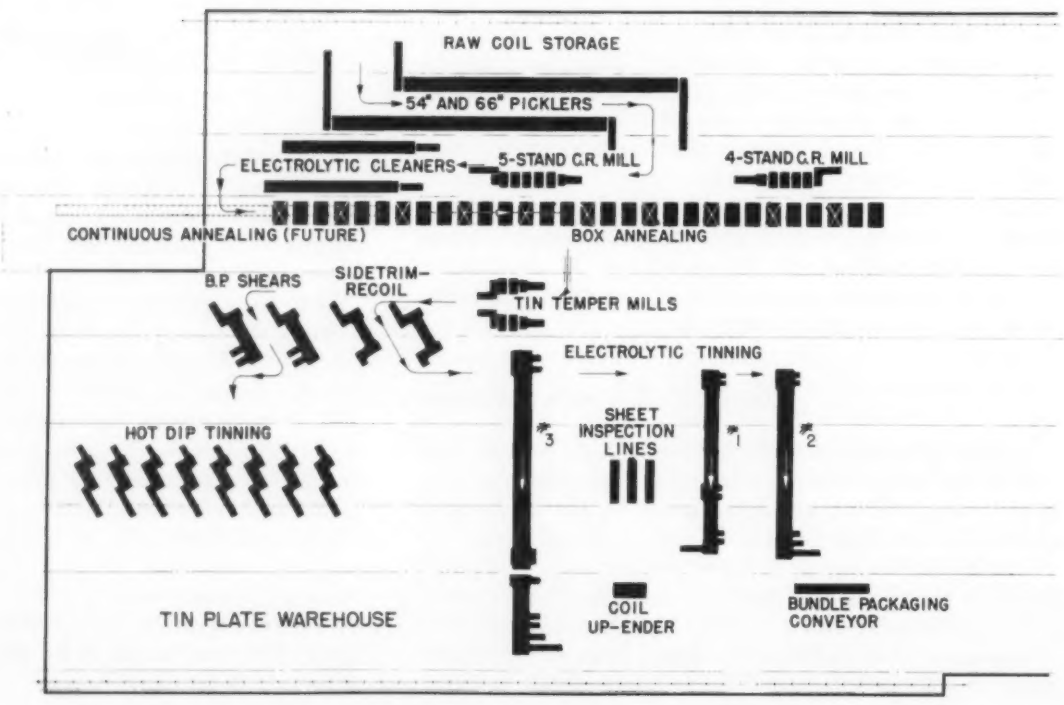



**Figure 1 — Layout of coil preparation and plating facilities shows excellent flow pattern.**

5-stand cold reduction mill, two electrolytic cleaning lines, a 10-furnace box annealing operation, two tin temper mills, two coil preparation lines and finally, three electrolytic tinning lines.

This Figure also shows two black plate shears and hot dip pots for producing hot dipped tinplate. The other equipment shown includes sheet inspection and reclassification lines, an upender for palletizing tinplate coils, and a tinplate bundle packaging line. Also indicated, in dotted outline, is the new 1500-fpm continuous annealing line which is currently under construction and scheduled to start up in 1960.

Except for the units indicated as being under construction, the No. 3 electrolytic tinning line is the newest facility in the sheet and tin mill. Design work for this line began in May, 1955, and the installation was completed in March, 1958.

Figure 2 indicates the elevation layout of the line. It extends into the tinplate warehouse and ends approximately four ft from the main truck shipping aisle.

The line is 401 ft long and has four operating levels, ranging from 60 ft below the mill floor at the looping pits to 21 ft above the floor at the melting tower. It has 184 miles of wiring and a total connected hp of 4147, divided between 131 d-c and 101 a-c motors. There are 174 individual rolls in the line, and approximately 1550 ft of strip passline from the entry end to the delivery end of the line. The top operating speed at normal voltage is 1250 fpm. This line was designed for a strip width range of 20 to 38 in. and a strip thickness range from 0.0061 to 0.015 in.

A view of the entry section of the line is shown in Figure 3. Coils are uncoiled alternately from each of two expanding type uncoiler mandrels equipped with coil cars and coil unloading skids. This equipment is designed to handle 30,000 lb maximum uncoated coils with a maximum outside diam of 72 in. The coil unloading skids store three standby coils ahead of each uncoiler mandrel. A motor-operated double-cut shear is provided for preparing the head end of each coil prior to welding.

Coil ends are joined by a 75-kva double seam welder which has a built-in shear for cutting the end of the completed coil. The welding wheels are larger than normal diameter (28 in.) and the welder anvil can be shifted to three different positions. These features provide for reduced maintenance and delay time.

A two-roll entry bridle pulls the strip from the uncoilers and feeds it into a double free-hanging looping pit. The two loops provide approximately 240 ft of usable strip storage which permits momentary stopping of the entry section for welding coils while the remainder of the line continues to run at a reduced speed of approximately 550 fpm.

The processing or main section of the line begins at the drag bridle immediately following the storage loops and terminates at the drive bridle, some 170 ft away. The drag bridle consists of four 36-in. diam rubber covered rolls with individual drag generators which total 75 kw.

The two bridles are designed to supply 5000-lb tension to control strip tracking. Between these two bridles, the strip passes through the various processes and is converted to finished electrolytic tinplate for coiling or shearing.

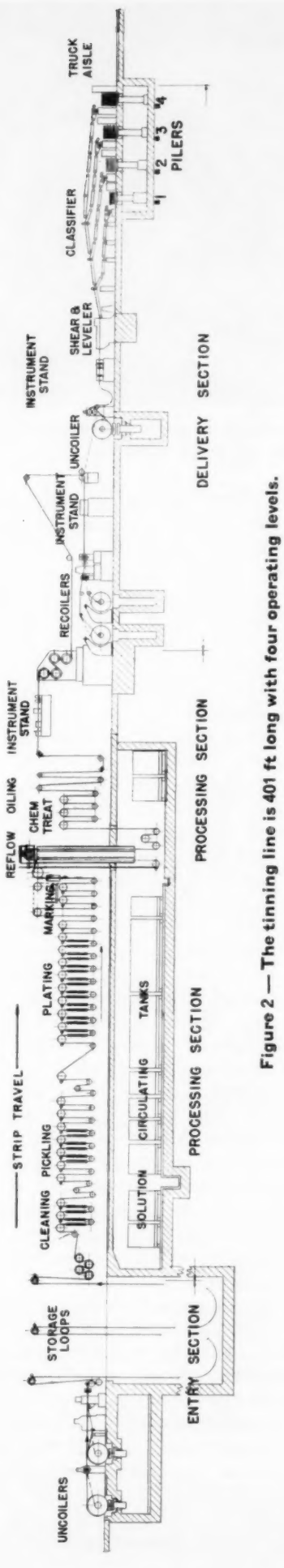



**Figure 2 — The tinning line is 401 ft long with four operating levels.**

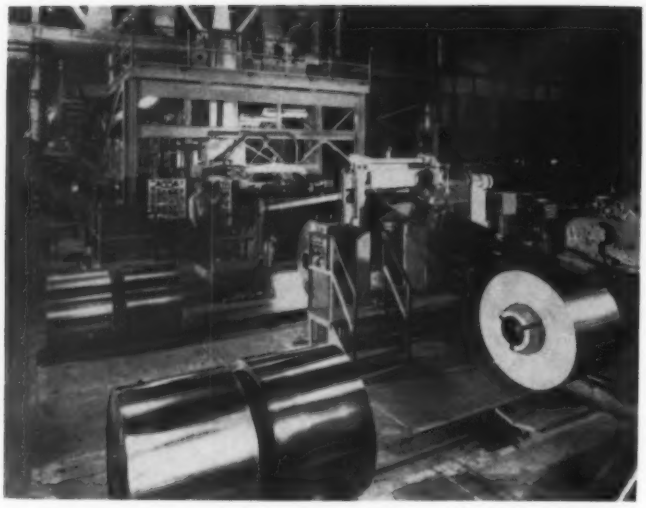


**Figure 3 — Coils of up to 30,000-lb and 72-in. diam are handled by the line entry equipment.**

The first of these processing units is an alkaline electrolytic cleaner section. It includes two tanks with 40,000 amp of electrolytic cleaning capacity in four vertical passes. When the strip leaves the cleaning tanks, it passes through a two-brush scrubber and each side of the strip is scrubbed with a nylon brush while being sprayed with cleaner solution. Emerging from the scrubber, the strip passes through a water spray rinse tank where the cleaning solution is thoroughly removed from the strip.

The strip passes next into the pickling section and through six vertical passes of electrolytic pickling in a 3 to 12 per cent sulphuric acid solution. A total of 30,000 amp of electrolytic pickling capacity is available in these three tanks. A fourth pickling tank is a dip tank that may be used for chemical pickling only. The strip is dip rinsed and then simultaneously spray rinsed and scrubbed in a second scrubber to prevent carryover of pickling solution to the plating solution.

For the plating process, eight vertical plating tanks are used in various combinations according to the coating weight desired. The plating tanks are nothing more than a series of electrolytic cells in which the strip is the cathode, bars of tin are the anodes and both are immersed in an electrolyte which is an aqueous solution containing stannous tin, phenolsulphonic acid and addition agents. The tin is applied progressively to the strip as it passes through each of the plating tanks and the desired coating weight is reached when the strip emerges from the last tank. The coating thickness is directly proportional to the amount of current applied per unit of time. This current can be accurately set for a given speed and is then automatically regulated to match varying line speeds.

A total of 100,000 amp of electrolytic plating capacity is available in this section. This total current can be divided equally to anodes on the top and bottom of the strip in five of the plating tanks or 30,000 amp can be switched to top anodes in three additional tanks. This latter arrangement provides 80,000 amp on top of the strip in eight tanks and 20,000 amp on the bottom in two tanks for making "differentially-coated" tinplate.

After leaving the plating section, the strip passes through two vertical dragout tanks. Here it is rinsed with dilute electrolyte to remove the surface film of operating electrolyte and to recover most of the valuable tin which otherwise would be carried out on the strip.

The strip passes from the dragout tanks, through wringer rolls and hot air dryer chevrons, being prepared for the tin reflow process. Before entering the reflow tower, two separate methods are provided for marking differentially coated tinplate. Either side of the strip can be marked to a whitish appearance by an electrolytic treatment of the strip. The alternate marking process involves the application of a light diamond pattern on the 0.25-lb side. The strip is dried again with hot air after either of these marking processes.

In the reflow tower, sometimes called the melter tower, current from two 1500-kva transformers is passed through the strip to heat it to the melting point of tin. This heating causes the tin to flow and attain a bright surface. The melting current is adjusted to cause the tin to flow immediately before entering the quench tank at the exit side of the reflow tower. This adjustment prevents formation of excessive iron-tin alloy which may impair solderability. Choke coils and grounding rolls at both ends of the reflow tower prevent current leakage along the strip into other processes.

The brightened strip next passes into the chemical treatment section which consists of two vertical electrochemical treatment tanks and a spray rinse tank. The treatment solutions vary according to customer requirements and the end use of the tinplate. Solutions commonly used are chromic acid and sodium dichromate. Electrolytic action is not used with chromic acid. There are 5500 amp available for electrochemical treatment. The electrochemical treatment removes the porous oxide film on the strip after reflow and replaces it with a relatively impervious film to improve abrasion resistance, prevent storage discoloration, and to improve lacquering and soldering properties.

After thorough hot water rinsing, the strip passes through wringer rolls and a hot air dryer before entering the emulsion oiling unit. This line has facilities either for emulsion oiling or for electrostatic oiling to apply a light film of oil on the strip. This film helps prevent surface abrasion during subsequent handling and facilitates feeding sheets to high-speed machines. An emulsion of cottonseed oil and water formerly was the most common oiling medium. The use of a more stable synthetic oil called dioctyl sebacate has become more prevalent. The oiling process completes the treating cycle for the tinplate and it is now ready for coiling or shearing.

The main section of the line terminates at the main drive or pulling bridle. Like the drag bridle, it consists of four 36-in. diam rubber covered rolls. Each roll is individually driven with motors of 75, 50, 30, and 20 hp respectively. As mentioned previously, this bridle is designed to pull 5000 lb of tension to control strip tracking through the line.

After leaving the drive bridle, the strip passes under a deflector roll and up to a second deflector roll some 25 ft above the mill floor. From this point, the strip drops vertically to provide a 15-ft passline for top and bottom strip inspection. The base of this passline is

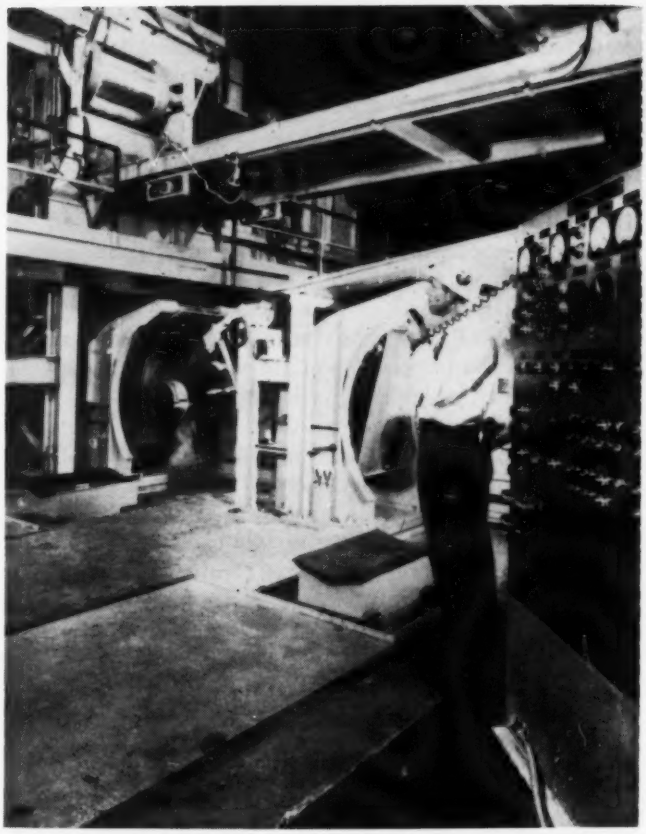


**Figure 4 — Horizontal belt wrappers are automatically retracted during the recoiling cycle operation.**

the point where the strip continues in the normal process flow direction for the shearing operation or doubles back in the opposite direction for coiling.

Immediately ahead of the two coilers, the strip passes through a snip shear which cuts the strip at speeds up to 450 fpm and alternately directs the strip to one or another of the two coilers.

The coilers shown in Figure 4 are equipped with horizontal belt wrappers, coil cars, and strip alinement equipment. Coils in excess of 20,000 lb with an inside diameter of 16½ in. can be produced by welding. The strip alinement equipment is equipped with cams for stagger winding of coils. Most of the coils on this line are currently being stagger wound. Sequencing controls are provided to make the complete coiler transfer cycle automatic after the cut button on the snip shear is operated; even the belt wrapper retracts automatically. An interlock prevents a coil from being wound on either mandrel unless the mandrel has been expanded.

Figure 5 indicates the arrangement of the shearing section of the line. When processing cut sheets, the strip leaving the inspection tower passes through a set of pinch rolls into a shallow loop immediately ahead of the shear and roller leveler. The leveler, an 18-roll machine with two sets of measuring rolls, serves the dual purpose of flattening the strip and accurately feeding it into the shear without slippage. The shear itself is the rotary drum type with approximately 9-in. shear drums. It is equipped with interchangeable drum head assemblies for quick knife changes. Shear cut settings can be made in $\frac{1}{16}$ in. increments by the selection of one of the 490 possible gear combinations.

On this figure an additional uncoiler immediately prior to the shear loop at the delivery end is shown. In effect a separate shear line can be operated at the same time the line is processing tinplate coils. During construction, this shearing section, with the uncoiler, was completed first, which permitted the tuning of the shear and classifier before the rest of the line itself was completed. When operated as a shear line, the shear and classifier run at a steady speed and the uncoiler speed is varied to maintain the proper level in the shear loop. When the shear operates with the line, the speed of the leveler and shear is varied to maintain the loop.

After shearing, the sheets pass to the high-speed classifier which is divided into four flights of conveyor belts leading to four separate pilers. The first piler receives all sheets that are automatically rejected for pinholes or for off-gage. It also can receive sheets that are manually rejected from visual inspection. The second piler primarily receives sheets rejected from visual inspection but can also receive rejectable sheets automatically when the first piler is locked out for cobbles or bundle rejects. The third and fourth pilers are for prime sheets only.

Figure 6 is a pictorial view of the classifier. There are numerous permanent magnets and electromagnets located under the conveyor belts to hold the sheets firmly to prevent skewing. Three sets of electromagnetic rolls are used for diverting the sheets into the various pilers. Four contoured permanent magnet rolls, one on each flight, lap the sheets prior to piling. This method of lapping is in contrast to the old method of using flipper plates where each sheet is "pitched" into the air before lapping. The classifier is designed to ensure that the sheets are under magnet and belt control at all times.

A scale is located near the end of the motorized runout conveyor from the No. 4 prime piler for weighing completed bundles which are ready for packaging.

## ROLLS

Rolls are the life blood of a tinning line because of their great number and the varied and exacting functions which they must perform. Rolls constitute one

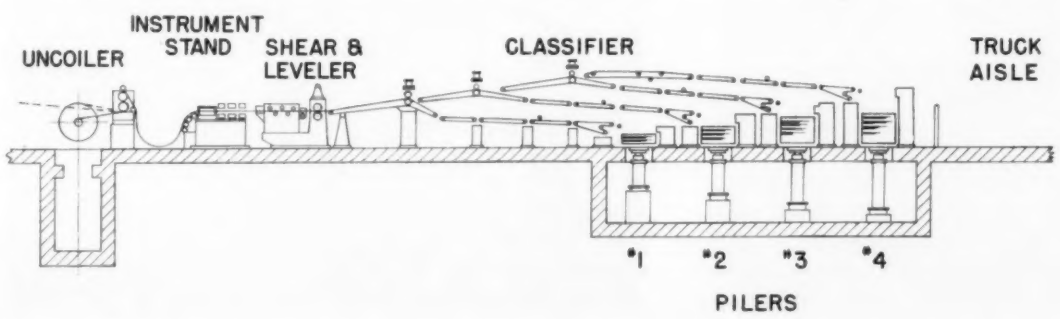



**Figure 5 — The shearing and classifying section of the line can be operated separately while the line is processing coils.**

**Figure 6 — Delivery section of the classifier shows the four pilers which control sheet movement with magnetic rolls.**

of the major maintenance expenses on the line and, therefore, must be carefully designed to perform specific jobs with a minimum of failure.

All rolls in the line have a 46-in. face width and all but small carrier rolls are motor driven. In the processing section, helper drives are combined into two wet groups and two dry groups. The drives are not intended to actually pull the strip, but rather to overcome the friction and inertia of the rolls.

The cleaner conductor rolls are nickel-plated; the pickle section has carbon conductor rolls; and, the plating, marking and chemical treatment sections have chrome-plated conductor rolls. All of the conductor rolls in the line are 24 in. in diam and have current-carrying capacities of 20,000 amp each.

Originally, almost all of the deflector rolls in the line were laminated, plastic rolls but these are satisfactory only as dry rolls prior to plating. Plastic rolls after plating have a tendency toward "pick-up" which mars and dents the tinplated strip.

All holddown rolls and rubber wringer rolls are 10 in. diam 80 durometer neoprene-covered. Each rubber wringer roll is driven and is paired with a 10-in. stainless steel idler roll.

## ELECTRICAL

The line is supplied with power at 6900 volts. The high-voltage switchgear feeds two 3000 kva air-cooled dry-type transformers which, in turn, supply 480-volt power to the line.

The tin line drive electrical equipment was designed for a normal top speed of 1250 fpm. The entry section of the line provides for speeds up to 1630 fpm for refilling storage loops.

A 100-kw constant-potential exciter supplies excitation for the field and control circuits. Individual units such as uncoilers, bridles, classifier flights, etc., have individual generators. Some of these generator sets are shown on Figure 7. Helper drives receive power from four generators. The dry helper drives are current regulated and the wet helper drives are voltage matched. Tachometers are installed on key wet helper drives to aid the operator in speed matching with line speed.

All of the direct current for the primary electrolytic plating and treatment processes is supplied by 24-volt 5000 amp germanium rectifiers. Rectifiers were chosen over motor-generator sets because of lower initial cost, higher efficiency, and the absence of brushes or moving parts.

There are 39 magnetic amplifier type regulators mounted on the panels to control the motors and other functions, such as plating, reflowing, etc.

The line has more than 20 operator stations with control devices which are mounted on satin-finish stainless steel. Figure 8 indicates the main operating control panel.

A synchrotie transmitter is mounted on the drive bridle with a remote synchrotie receiver which drives seven tachometers and two pilot exciters. They furnish speed signals for the various regulating and metering functions on the line.

## LUBRICATION

All rolls in the line, other than those in the processing

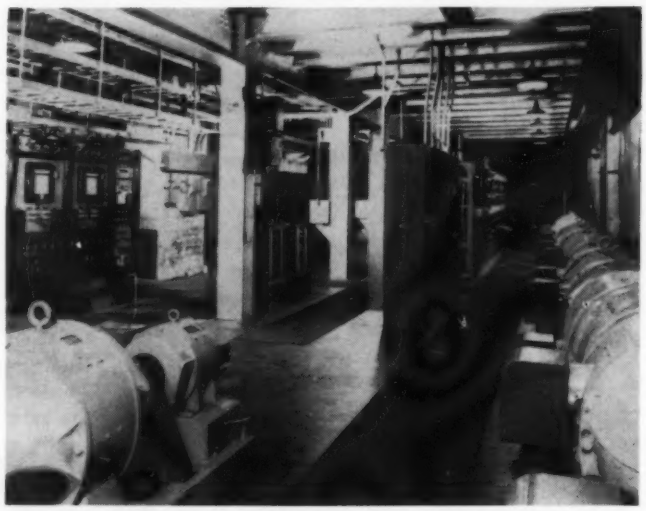
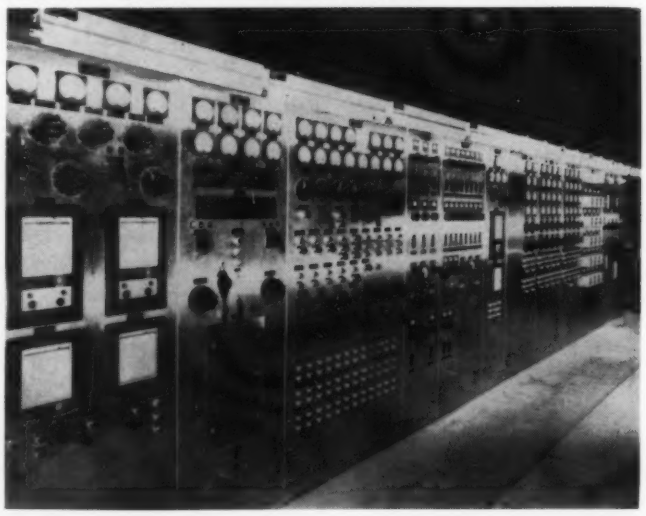


**Figure 7 — Many separate generators supply power to individual units.**

**Figure 8 — View of the main control panel indicates the complex regulation necessary for proper tinning.**



section, are equipped with centralized, manual type grease systems.

All holddown roll bearings are prepacked with grease and are protected from the influx of solutions by a special type seal which is shown on Figure 9.

All rolls in the process section are equipped with oil mist lubricating systems and have warning devices that indicate when any system of lubricators is not functioning properly. Our experience with oil mist systems has been very satisfactory. The main value of mist systems in the process section is the elimination of solution contamination caused by overgreasing or drippage.

## SOLUTION SYSTEMS

Each treatment in the processing section has a complete recirculating system. Solutions are continuously pumped from basement storage or recirculating tanks to the processing tanks. All pump suctions are located above the bottoms of the storage tanks to insure that solution contaminants settle to the bottom and are not recirculated into the treatment tanks. The overflows in the processing tanks are designed to perform a continuous skimming action across the width of the tanks. As a result, greases, oils or dirt cannot accumulate on the surface and eventually pull out on the strip.

## INSTRUMENTATION

The processing of electrolytic tinplate must be controlled very closely to meet exacting metallurgical, physical and appearance quality standards. Since the ultimate product is usually a food container, a large equipment investment was made to insure that these quality standards are met.

There are four noncontacting thickness gages on this line for rejecting off-gage coils, for controlling the strip processing, and finally for automatically rejecting any sheets that are not within gage tolerances. One gage is located at the entry end, two are in the processing section, and one is in the delivery end ahead of the shear and leveler.

Four pinhole detectors which are capable of detecting holes 0.0005 in. in diam are included at the delivery end of the line. Two of these are for coiling and two are for shearing. Each pair of detectors consists of one active and one standby unit. As a result the strip is never processed without coverage by a pinhole detector. Again, the detector at the shearing end causes any sheet with a pinhole to be automatically rejected.

Each anode bridge in the plating section is equipped with a current time meter. In this way, anode thickness can be accurately controlled and a uniform coating thickness across the width of the strip can be maintained.

A rotating mirror inspection device has been provided at the inspection station. The rotating mirrors are synchronized with strip travel and provide repetitive, still images for closer inspection. A lighting system is being developed which is compatible with both normal strip inspection and rotating mirror inspection to make the latter more effective.

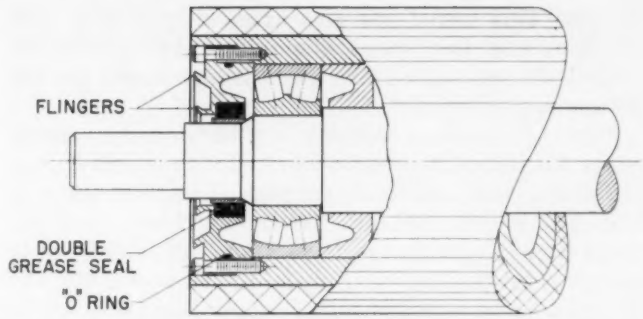



**Figure 9 — Holddown roll bearings are prepacked and protected by the illustrated seal.**

## SPECIAL DESIGN FEATURES

Several new design features have been included in this new line which differentiate it from our other two lines. These features are intended to provide safer working conditions, to improve quality, to lower maintenance, and to minimize investment costs.

The basic line layout, in plan and elevation, is a distinct departure from previous designs. The processing section was elevated one story, thereby placing the main operating level on a mezzanine. In this way, the following advantages were attained:

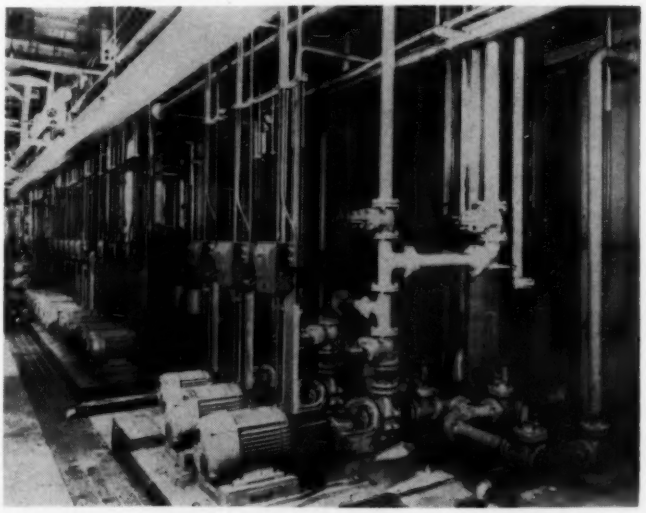
1. All storage or recirculating tanks are located directly beneath the processing tanks. As a result, pipe can be run vertically from the recirculating pumps and the amount and complexity of the piping is greatly reduced. The size of the excavation and basement is also reduced. Figure 10 is a view of the pump arrangement and the straight vertical piping which runs to the processing tanks above.

2. Almost all of the process tanks were placed above the mill floor. Better housekeeping was an immediate benefit; faster and safer maintenance could be performed on sink rolls, tank bottoms and sink roll drives; and the entire line is exposed and can be watched more easily and carefully.

3. All the rectifiers for the electrolytic processes were placed on the mill floor. This location places the equipment closer to the processes. The excavation for electrical basement was reduced accordingly.

4. A tower structure was added to the standard loop-

**Figure 10 — Recirculating pumps and piping are located directly beneath their respective processing tanks.**



ing pit. This tower provides extra strip storage and increases the line speed that could be maintained while coils are welded. As a result, low-speed plating defects are minimized.

Figure 11 shows a complete conductor roll assembly ready for installation in the line. This assembly illustrates the most outstanding design changes of the new line. The entire assembly was designed as a unit because it must operate as a unit. To install this assembly it is first set in place and secured with four bolts, the air cylinders are connected to supply lines, pressure is set on the conductor roll brushes, and the motor is plugged into the power supply.

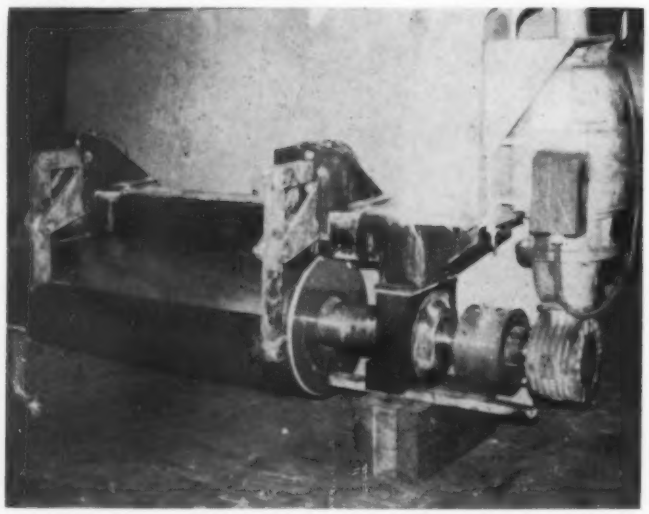
In addition to the quick-change aspect of the assembly, there are several individual design features which are significant as follows:

1. The vertically mounted conductor roll drive motor has a floating spring mount to remove the motor weight from spiral bevel drive gears. This arrangement has required a minimum of maintenance, but the greatest advantage is the release of floor space for necessary operating area. Figure 12 provides an impressive view of these motor installations on the line, and clearly indicates the added operating area which is available.

2. Holddown roll pressure is applied by two diaphragm-type air cylinders which are equipped with individual pressure controllers and gages to insure that uniform pressure can be applied to both ends of the holddown roll. This feature is particularly important in controlling roll wear and strip tracking. A hand-operated air valve is supplied at each roll and rethreading after strip breaks is greatly simplified. All rolls can be quickly removed from the conductor rolls. As each roll is threaded, the holddown roll is lowered and the strip can be power driven successively from one tank to the next. When the line stops, a solenoid valve in the main air supply line relieves the pressure on all holddown rolls in the line. As a result, the rolls do not develop flat spots which would prevent proper turning.

3. The conductor roll bearing blocks are mounted on top of an I-beam support structure rather than being suspended as in previous lines. Thus, a compression mounting is made that is much more stable. Also, it ties the conductor roll to the sink roll in a common mounting reference. This line has had no serious tracking problems since it was started almost a year ago. We attribute this performance primarily to this mounting feature. An additional advantage of this compression mounting is the ease with which it can be removed by an overhead crane.

**Figure 11 — Conductor roll assembly is designed to be installed as a unit.**



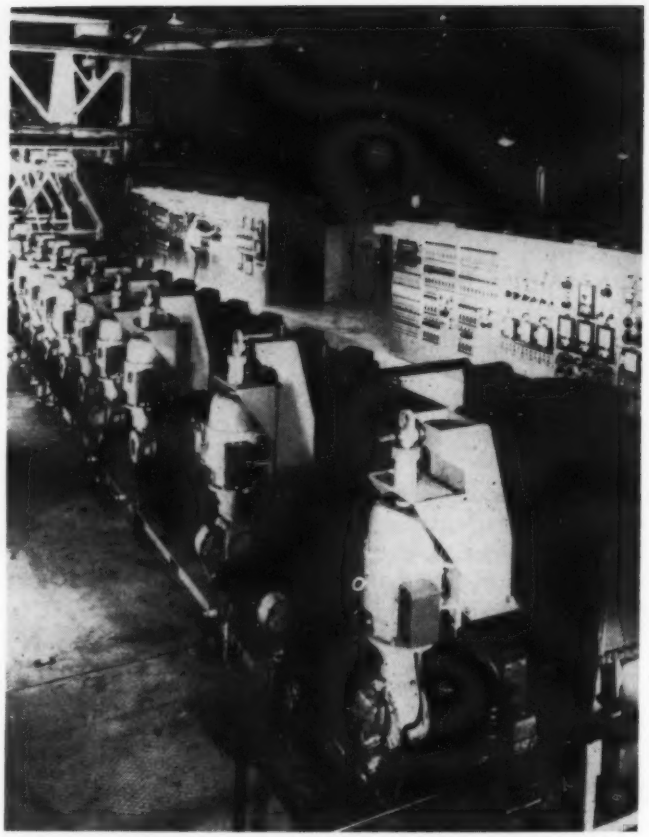


**Figure 12 — The weight of the roll drive motors is supported by a spring mount to decrease overhung shaft loading.**

4. This arrangement permitted the use of U-shaped brush sickles formed from bar copper instead of more expensive sickles cut from plate copper.

Figure 13 indicates another design change which has greatly improved sink roll alinement and strip tracking. The old method of mounting tank bottoms required bolting rubber covered flanges together. Uneven rubber thickness and laps made it almost impossible to insure level alinement of the tank bottom and sink roll. The new method provides stainless steel flanges on the tank top and tank bottom. A thick rubber gasket is placed between the flanges for a seal. The two flanges are bolted together and the gasket is compressed until both flanges bear against a stainless steel spacer block. This provides an excellent seal and maintains perfect reproducible alinement.

Figure 14 indicates the old and new design application for the No. 2 conductor roll in the reflow process. In the old design this roll is submerged in water in a quench tank. With this arrangement, the holddown roll often failed to turn and scratched the strip. Foreign bodies in the quench water tended to pick up on the conductor roll and cause arc spots. The new design places this conductor roll immediately after the quench tank. While this arrangement requires more power to operate the reflow process, it has virtually eliminated the two important quality defects

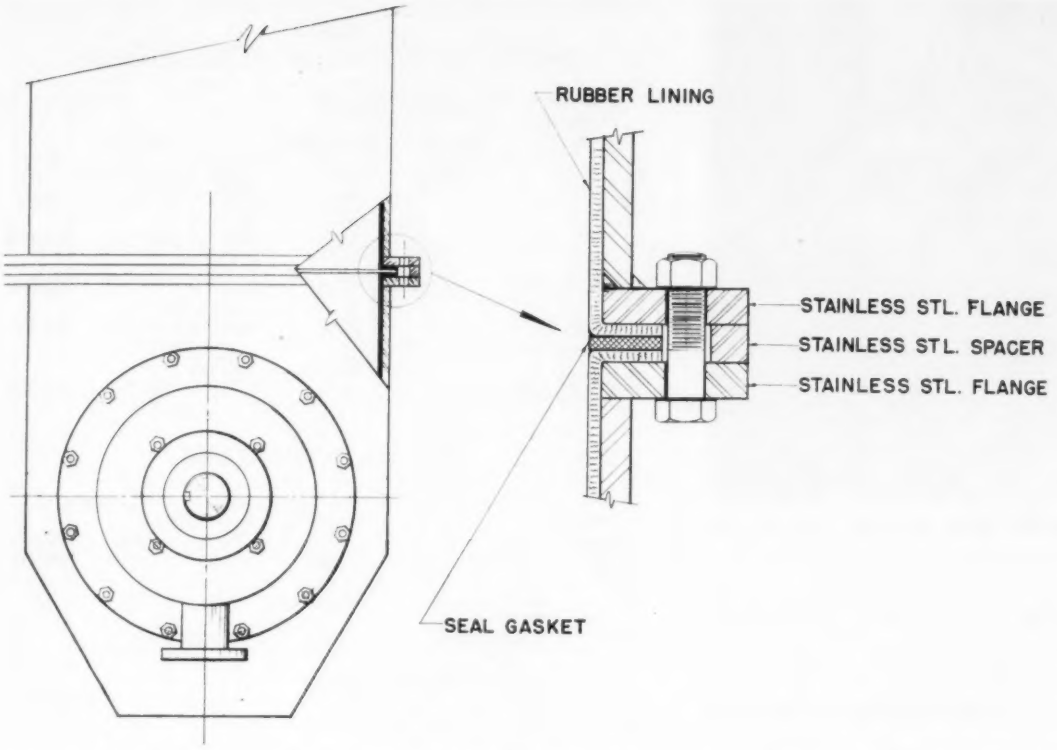



**Figure 13 — An improved method of mounting tank bottoms simplified alinement and sealing.**

caused by the old method. The new design has the additional benefit of eliminating a set of wringer rolls which were found to be difficult to maintain. Note also the use of one large 36-in. diam insulated roll in the top of the tower instead of the two-roll arrangement previously employed.

All anode bridges on the new line have the current applied in the center of the bridge. Feeder bars must be brought to one side of the tank only, and current distribution in the anode bridge itself is more uniform.

A magnetic amplifier strip break detector has been incorporated to bring the line to an emergency stop if the strip breaks in the center section of the line. Tachometer signals are fed into the magnetic amplifier from the drive and drag bridles. Any unbalance in the two signals will actuate the emergency stop circuit.

Figure 15 provides a view of the control panels in the electrical basement. An innovation believed to be the first of its kind is the use of steel panels as d-c variable voltage boards instead of the conventional slate panels. Standard contactors and devices are used with melamine bushings to insulate them from the steel panels.

Many of the design features mentioned were the direct result of ideas submitted by operating and maintenance personnel. Numerous joint meetings of all mill departments and extensive brain-storming sessions contributed to the development of this line. It stands as an excellent example of the results which can be obtained with a free exchange of ideas among

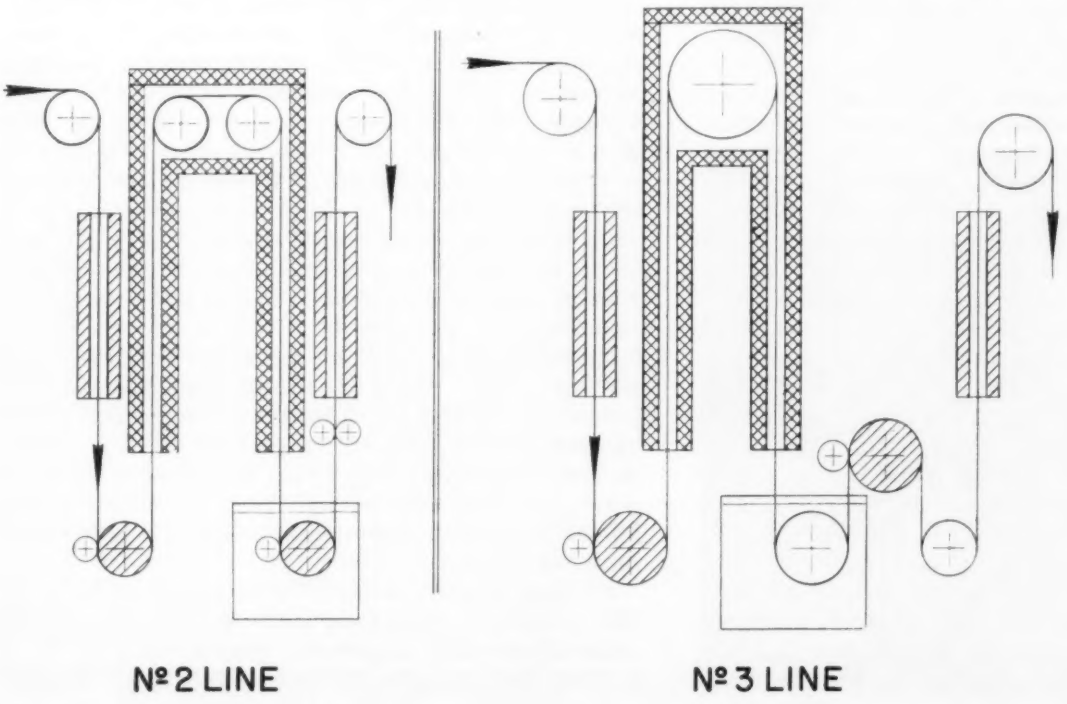



**Figure 14 — A change in the placement of a holddown roll has improved strip quality.**

**Figure 15 — Steel panel boards were used in place of the conventional slate panels.**

plant engineering, the mill builder, and the various departments of the plant.

## OPERATING COMMENTS

This part of the paper will cover the operating aspects of the new electrolytic tinning line, with particular emphasis on problems associated with a new unit.

Table I gives the gages and sizes of tinplate products which have been produced at Pittsburg. Sizes other than those indicated are handled on an inquiry basis. The ranges are changed as experience warrants.

The large investment required for a modern electrolytic tinning line makes it mandatory to reduce tune-up and break-in time to an absolute minimum. Since the start-up of the new line at Pittsburg was very successful, a review of the techniques used will be discussed. Figure 16 indicates the time consumed and a comparison of actual and expected performance.

To obtain the start-up performance on the new line, the following methods were used:

*1. Selection of supervisors*—The general foreman of electro-tinning selected an experienced turn foreman, with a technical background and an interest in new methods. The general foreman of maintenance selected a maintenance turn foreman with electro-tinning line experience. These two foremen were assigned to this unit sixty days prior to try-out target date to follow the final stages of construction and to become familiar with the design because of the variety and complexity of the solution handling and electrical control systems.

*2. Start-up procedure*—(*a*) *Shear and classifier section*—This line is equipped in a manner that allows the shear and classifier to be operated as a separate unit. Because this part of the line must be operated with minimum delays in order to tune-up the processing section, it was started as a separate unit shearing black plate reject coils. Coated coils were then sheared to adjust completely the shear and classifier. The entire crew of six men were used to give them experience with this unit and its new design.

(*b*) *Processing section*—The line was started recoiling without cleaning or plating the product, allowing the operators to become familiar with the line and the engineers to tune-up the electrical and mechanical

**Table I**
**Electrolytic Tin Plate Coils and USS Black Plate Coils**

| Basis weight-lb. | Coil Widths, in. | | Grades |
|---|---|---|---|
| | Minimum | Maximum | |
| 70 | 23¼ | 32 1/16 | MRT-3 and MRT-4 |
| 75 | | 34¼ | MRT-2–MRT-4 |
| | | 33 | MCT-4 |
| 80 | | 35⅛ | MRT-1–MRT-4; MCT-4 and MCT-5 |
| 85, 90, 95, 100 | | 36⅛ | MRT-1–MRT-4; MCT-4 and MCT-5 |
| 107, 112 | | 36⅛ | MRT-1–MRT-4; MCT-4 and MCT-5 |
| | | 34 15/16 | MCT-6 |
| 118, 128, 135 | | 36⅛ | MRT-1–MRT-4; MCT-4 and MCT-5 |

**Electrolytic Tin Plate Sheared**

| Basis weight-lb | Grade | Widths, in. | | Lengths, in. | |
|---|---|---|---|---|---|
| | | Maximum | Minimum | Maximum | Minimum |
| 65 | MRT-3 and MRT-4 | 30⅜ | 23¼ | 35 | 18 |
| 70 | MRT-3 and MRT-4 | 32 1/16 | | | |
| 75 | MRT-2–MRT-4 | 34¼ | | | |
| | MCT-4 | 33 | | | |
| 80 | MRT-1–MRT-4; MCT-4 and MCT-5 | 35⅛ | | 42 | |
| 85 | MRT-1–MRT-2½ | 36⅛ | | | |
| | MRT-3–MRT-4; MCT-4 and MCT-5 | | | | |
| 90 | MRT-1–MRT-4; MCT-4 and MCT-5 | | | | |
| 95, 100 | MRT-1–MRT-4; MCT-4 and MCT-5 | | | 42½ | |
| 107, 112 | MRT-1–MRT-4; MCT-4 and MCT-5 | | | | |
| | MCT-6 | 34 15/16 | | | |
| 118, 128, 135 | MRT-1–MRT-4; MCT-4 and MCT-5 | 36⅛ | | | |

components. Ten days were required and reject black plate coils were used. A sulphuric acid solution was then placed in the plating tanks, and the line was operated to tune the plating control system. Standard solutions were then placed in the several sections of the line and plating operations were begun. The final calibration of plating, pickling, chemical treatment, and melting electrical systems was accomplished in five days.

(*c*) *Complete line operation*—Next, the plant was ready to produce commercial material. Poor yields resulted initially as expected, but as the crew gained experience and refinements in equipment were made, full production was available in 90 days after the initial start-up. Two additional crews were selected and assigned to the line. The members of the initial or start-up crew were distributed among each of three crews. As shown on Figure 16, startup performance has been very good. This unit has now been in full production for ten months. A performance review of the new features is as follows:

*1. General arrangement*—The intent of installing the line completely above floor level was done to improve maintenance and inspection. Results to date have justified this arrangement. An example of the benefits

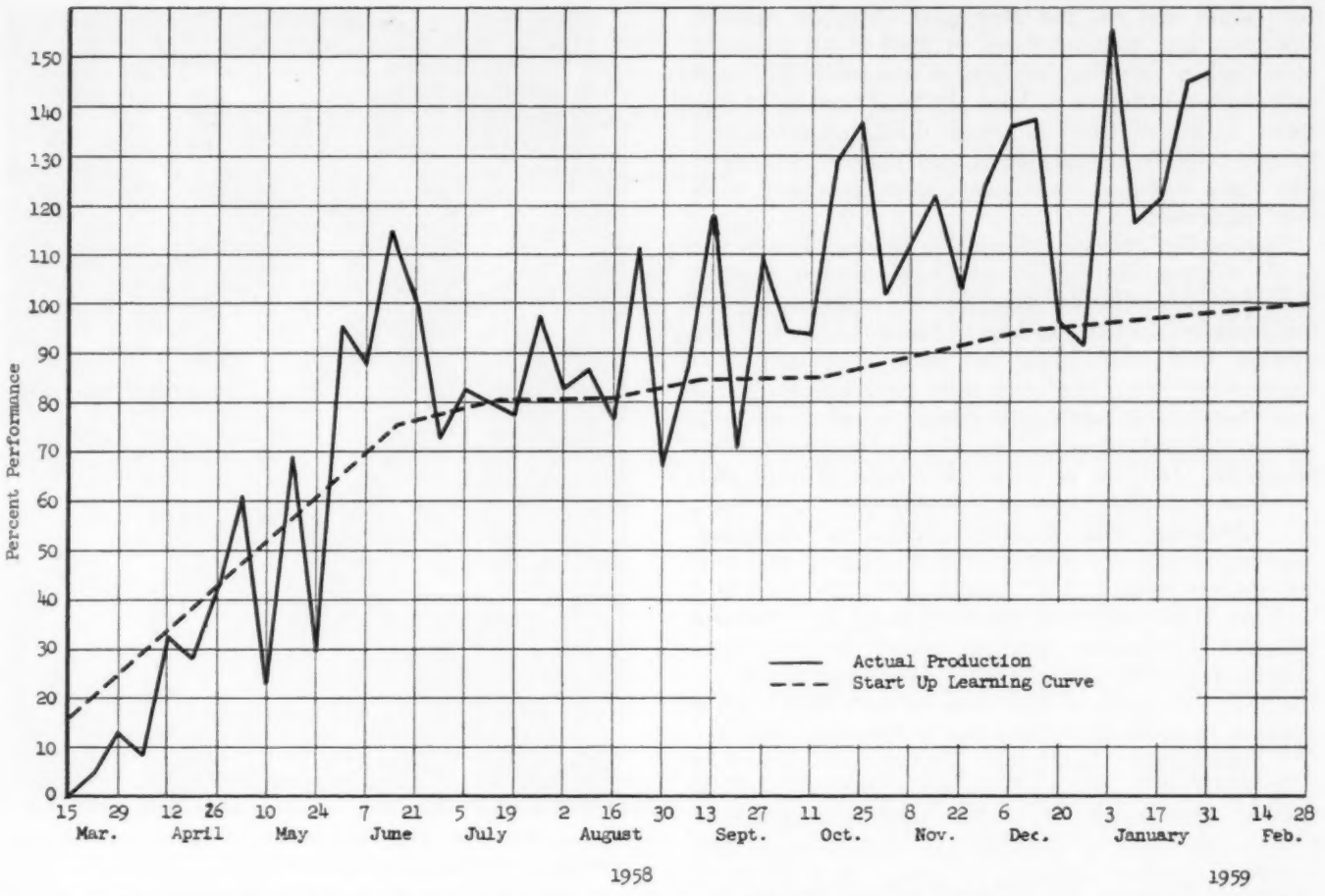



**Figure 16 — A comparison of actual and expected performance indicates that proper pretraining can decrease production training.**

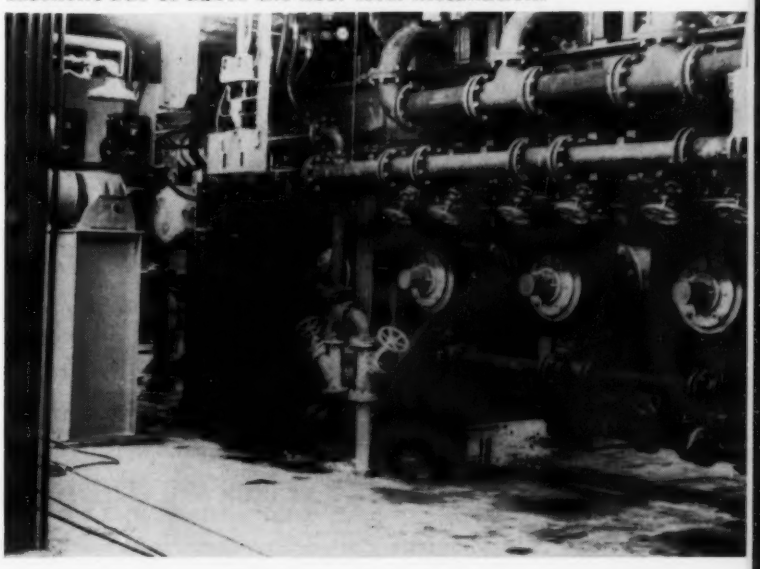
is shown in Figure 17 which indicates the free accessibility to tank bottoms and piping. The disadvantage of the arrangement is the inability of all members of the crew to see the center section assistant operator and, as a result, communication is more difficult. We believe the improved maintenance more than offsets this disadvantage.

*2. Entry Section*—The use of the free loop has been a problem somewhat during high-speed operation. Edge damage is difficult to control and continued attempts to improve the rotary guides and holddown roll arrangement are being made. Lighter than 70-lb basis weights may require considerable change in design. The coil handling and welding has been very satisfactory and a complete welding time of 12 sec is regularly obtained. The large diameter welding wheels have provided full twenty turn service and weld breaks are very rare. Strip guiding through the pulling bridle has not been a problem.

*3. Process Section*—Strip guiding is one of the most important considerations in this section. Initially, severe wrinkling occurred in the chemical treatment section. Misalinement of several sink rolls was found and corrected. The tuning of the inertia compensation at an accelerating rate of 60 fpm per second practically eliminated the problem after correcting the roll misalinement. The design accelerating speed was 125 fpm per second. Abrasion of the strip during and after coating has been minimized, and the individual roll drives throughout have been a justifiable expense. The wet or immersed rolls operating on voltage matching with line speed have operated with minimum strip abrasions. Careful operator attention is necessary to synchronize the speeds of these rolls with line speed.

The operation of putting anodes in the plating tanks has become a major consideration when heavy coating weights are produced. Consideration is being given to devising a semi-automatic handling system. The use of air cylinders on the holddown rolls has been a superior installation as compared to the spring-loaded arrangement. Conductor roll pick-up of tin particles has been

**Figure 17 — Accessibility to piping and tank bottoms is excellent due to above the floor level installation.**



very slight and roll life very good. A rough finished holddown and conductor roll is used in all positions except when very dry wringing is necessary. This will provide more friction to keep the rolls turning at line speed. It is felt that the 10-in. diam holddown and wringer rolls are justified based upon experience to date. The lines installed previously were provided with 8-in. diam rolls.

Coating the finished strip with a light oil film is one of the most critical operations in this section. Careful control of mixing and additions to the emulsion, proper temperature control, and good maintenance of the wringer rolls after oiling are most important. The electrostatic oiler has been used experimentally and may have advantages over emulsion oiling in some instances. Evaluation of this oiler has not been completed at the present time. A consistent and well distributed oil film is necessary in subsequent processes.

*4. Shearing and Recoiler Section—a. Recoiling.* Winding tensions of 1500 to 2000 lb are used and coils are stagger wound. The stagger presently used is 1 by 1 in. (1-in. build-up on the diam and 1-in. horizontal movement). Stagger winding assists in preventing distortion of strip shape. Transfer from one recoiler to the other is made at 375 fpm without problems in shearing or starting the head end on the entry mandrel.

*b. Shearing and classifying.* This unit has performed very well after minor adjustments and refinements The classifier appears to be the speed limiting part of this section. Speeds to 1100 fpm have been obtained with excellent shearing accuracy. It appears that the speed at which a sheet can be stopped at the piler will be the speed limiting problem. The shear clutches which are used to change sizes without stopping the unit have been erratic to date and an improved clutch is being installed.

*c. Product quality control.* Higher production rates provided by this unit have made rigid quality control imperative. Coil production particularly is very difficult to control since individual sheets cannot be inspected. Visual inspection equipment was provided as previously mentioned. In addition, coil ends are inspected and tested. Control of all solutions is maintained by regular testing. Temperatures and volumes are maintained at optimum values.

In summary, the following seem necessary to any start-up procedure:

1. Spare basic components should be ordered at the time the unit is ordered. This applies particularly to rolls which are in direct contact with the strip. Try-out time will be extended if spares are not immediately available.

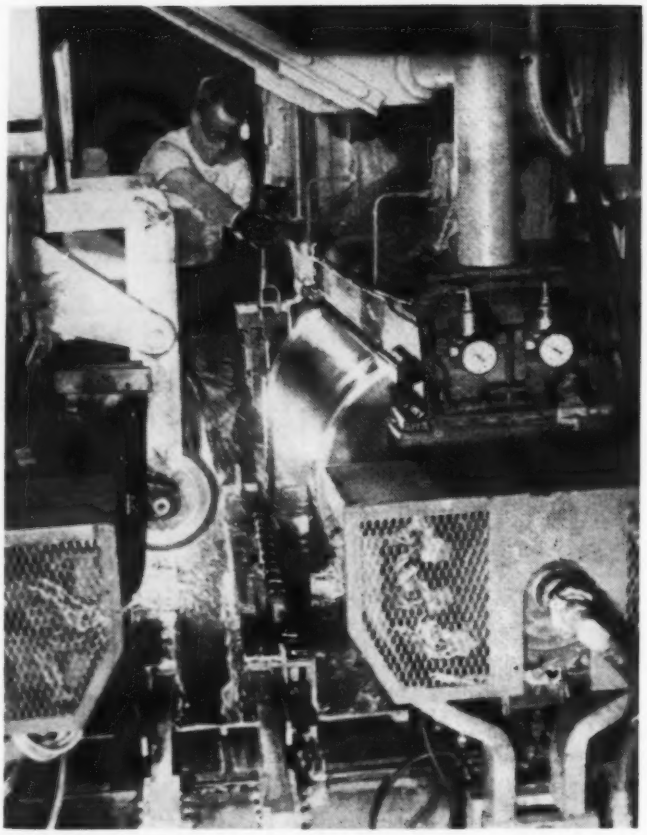


**Figure 18 — Installation of anodes is a problem during runs of heavy coating weight strip.**

2. Electrolytic lines should be placed on continuous operation as soon as possible. We feel that 30 days maximum on a one turn operation is all the time needed. Starting and stopping each day introduces problems which will delay tune-up and adjustment. This type unit must be operated continuously for long periods to properly evaluate and refine all components.

3. The skill, interest, and desire of the operating crew to learn to operate the new equipment is the most important consideration. The successful and economical start-up of the unit described was greatly affected by the cooperation which was obtained from the operating crews.

4. Maintenance and construction manpower must be available to make any necessary changes and relocations. Many problems may require several design changes before a successful method has been developed. The regular maintenance crew cannot be expected to accomplish this work as promptly as necessary to minimize start-up costs. ▲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*Though sintering plants are tailor-made there are common problem areas which affect maintenance and production quality.*

# Trouble Spots in Sintering Plants

by G. R. BAER, Manager, American Ore Reclamation Section,
and R. E. POWERS, Engineering and Construction Div., Koppers Co. Inc., Pittsburgh, Pa.

THE extensive construction of large sintering plants in the past few years has revealed many trouble spots. A "trouble spot" is an area or a situation which makes operation or maintenance difficult, hazardous, dirty, restrictive, expensive, or even impossible. It usually results in loss of production and increase in costs. A great many of these trouble spots can be related to the design of the plant, and many of them are correctible by changes in design.

Sintering plants, by their nature, require careful engineering design. Full understanding of conditions, painstaking attention to detail, and broad background of experience are necessary on the part of the designer. To the extent that these qualifications are met, the plant will avoid trouble spots. This is not to say that trouble spots will be eliminated, for even with the best design, areas of difficulty appear.

This paper discusses some of the outstanding trouble spots which have been observed in modern sintering plants, and points out some of the means adopted for overcoming them. In many cases the trouble was corrected in the plant experiencing it, but in some cases it could be overcome only in a subsequent plant of different design. While the paper deals primarily with the traveling-grate-type process, many items, particularly in the materials handling, apply also to the batch-type process.

Many of the subjects discussed are of a highly debatable nature. There are often many solutions to a given problem. The ones mentioned below proved to be good choices in the places where they were applied, but are not necessarily applicable to all situations. This is not a report on how to design or operate a sintering plant, but rather a collection of items from experience which enter into successful design and operation.

It may not be fully appreciated, even among engineers, that all sintering plants are different. They are tailor-made for raw materials, transportation, product delivery, available space, and many other factors. Each installation therefore has its own peculiar problems as well as those common to all sintering plants. This discussion will cover mainly the common problems.

Let us observe at the outset that sintering plants have always been troublesome. The first one for continuous sintering of ferrous materials was built in the United States in 1911. As late as 1949, when the American Iron and Steel Institute undertook a survey of sintering plants, they were largely on the outer fringes of concern of steel-plant management. They were staffed by untrained personnel and were largely shunned by everyone else. This situation is now almost completely changed. The new sintering plants are vital facilities for preparation of beneficiated burden for the blast furnaces. Furnace operators depend upon them, in many cases for processing a major proportion of their iron-bearing materials, and also increasingly for the metallurgical control of burden composition. Much of the capital-expansion money of recent years in the iron-making industry has been spent on sintering plants.

It will be convenient to organize the discussion under headings representing the types of engineering design encountered and to follow this with a short section on process, operating, and maintenance aspects.

## PROJECT AND PLANNING

Here is where many phases of the trouble start. In the project and planning stage of the plant, the engineers who determine plant layout and facilities have a big responsibility in avoiding known pitfalls.

The closest cooperation is necessary between the buyer and the engineering firm quoting on the work, to make sure that the design meets the needs and that the wisest choices are made from among the many alternatives available. Alternative materials of construction, equipment features, and design standards have a pronounced effect upon the cost, the operability and ultimate trouble of the plant which is built. The construction of sintering plants is a highly competitive field. Therefore, there must be a full understanding on those quality features of the plant design which will cost more in the beginning but save money in the long run.

## FOUNDATIONS AND STRUCTURAL

The foundation problems for sintering plants do not seem to be unique. There have been no failures in recent years where accepted engineering practices have been followed.

In the structural design, two items are of great importance: the support of the sintering machine, and the support of large moving equipment which has a tendency to vibrate.

The sintering machine is a rather delicate piece of heavy machinery. It requires level support throughout its length so that it will track properly. A deflection of $\frac{1}{16}$ in. in the supporting steelwork should be the design maximum. Support for the machine is preferably provided directly from the ground rather than from building steel. Machines which have been supported from building steelwork in an off-center position within a bay have suffered from tracking problems. The proper design for structural support of a large machine is shown in Figure 1.

Vibration from some equipment has caused serious difficulties. There have been a few instances where a large, rotating, balling drum has caused excessive building vibration. One remedy for this has been to insert a heavy concrete pad in the base of the balling drum. A vibrating hot-sinter screen mounted on building steel in one plant is responsible for severe vibration.

Ventilation has been a serious problem in the larger sintering plants. The time-honored expedient of tearing siding and roofing off the building is only a makeshift solution. Two large plants have been built with floors made entirely of grating and with an open-type monitor roof, as shown in Figure 2. This makes for a clean and comfortable plant.

## MATERIALS HANDLING

The description of a sintering plant as a huge materials-handling system is correct, even though in-

**Figure 1 — Correct support of the sintering machine independent of the building is important.**

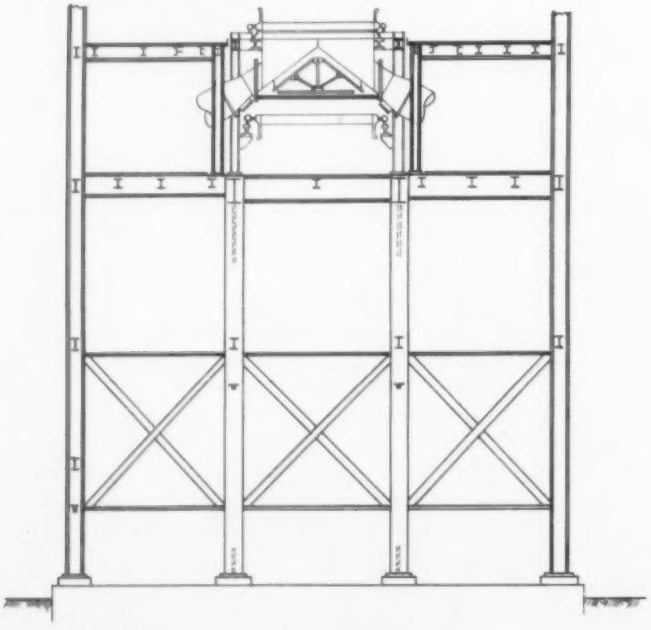


**Figure 2 — Ventilation problems have been reduced with the use of grating floors and monitor roofs.**

complete, and it spotlights the source of the bulk of the trouble encountered. Raw materials of a sticky and moisture-laden nature, and products of abrasive character must be handled continuously at high tonnage-rates.

It has taken some years and much sad experience to establish the necessary factors of design for coping with the characteristics of the materials and for anticipating the tonnages to be expected. It is now commonplace to design the materials-handling facilities of a size sufficient to carry materials for making 25 to 50 per cent more sinter than the nominal plant-capacity.

Troughed rubber-belt conveyors are the backbone of the system. They are used wherever material, temperature and plant layout permit, as they are the most dependable, trouble-free and economical transporters of bulk materials available. The capital investment in conveyor facilities greatly exceeds the cost of the sintering machine.

A number of plants have been built in which the conveyor idler widths have been arbitrarily chosen 6 in. wider than the standard for the belt width involved. This assists in belt training and provides the means of increasing belt widths at minimum additional expense if this is found necessary.

The angle of belt conveyors requires particular design consideration. The maximum angle should not exceed 18 degrees. For lump materials such as coarse ore, a maximum of 16 degrees is desirable to avoid objectionable spillage.

The ideal belt-conveyor system would have all drive and snub pulleys rubber-lagged. Pulley shafts would

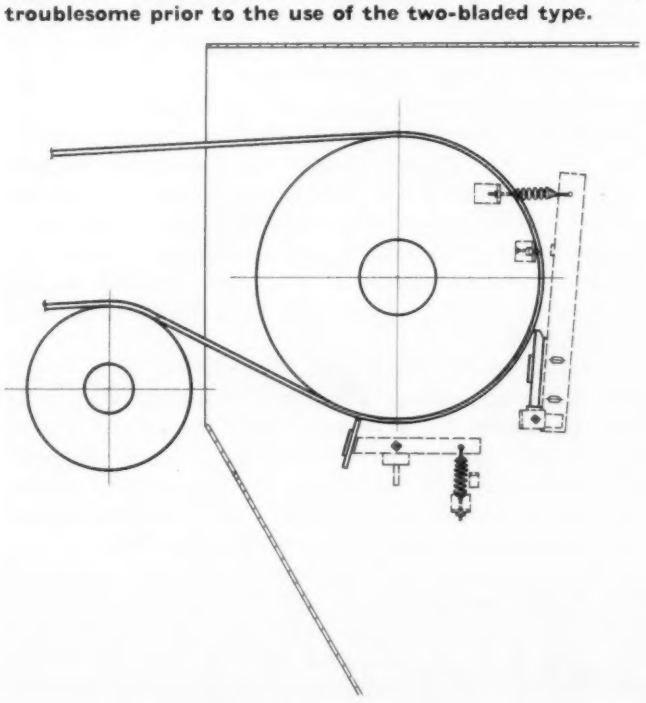
be equipped with anti-friction, self-alining, dust-tight pillow blocks. Rubber-disk impact idlers would be utilized at all loading points. Gravity or counter-weighted take-ups would be provided for conveyors 120 ft or longer, and screw take-ups would be used on shorter conveyors.

The lubrication of conveyor equipment may be manual or automatic. In either case it is essential that all pulleys and idlers be kept in operating condition to prevent undue wear on the belt and equipment.

For splicing belt, vulcanized splices are much preferred over belt-fasteners. In large sintering plants where there are enough splices to warrant the purchase of vulcanizing equipment and where a crew of men can be instructed in making such splices, they are an economical maintenance means. For emergency repairs, or for smaller plants, several types of metal fasteners are available. Fasteners which hold the belt ends tightly together are preferred to those types which leave open spaces at the joint. Care must be taken to have a straight joint. All metal fasteners require frequent inspection and must be renewed at the first sign of weakness. Industry could make use of an improved belt-fastener for emergency uses or splices in short conveyors.

Belt scrapers are a perennial headache in all conveyor installations. Sintering plants are no exception. There are many types of belt scrapers on the market, including counterweighted, spring-loaded brushes and herring-bone-tread rubber rollers. Scrapers are an absolute necessity in the handling of fine, wet or frozen materials. A recent belt-scraper installation which has proved superior to many other designs is shown in Figure 3. The assembly consists of two scrapers, each a spring-loaded rubber strip. The first is approximately tangential to the head pulley below its centerline and the second is approximately radial. All drippage is made to fall with the main flow or into the transfer chute below the pulley.

**Figure 3 — Belt scraper installations had proved very troublesome prior to the use of the two-bladed type.**



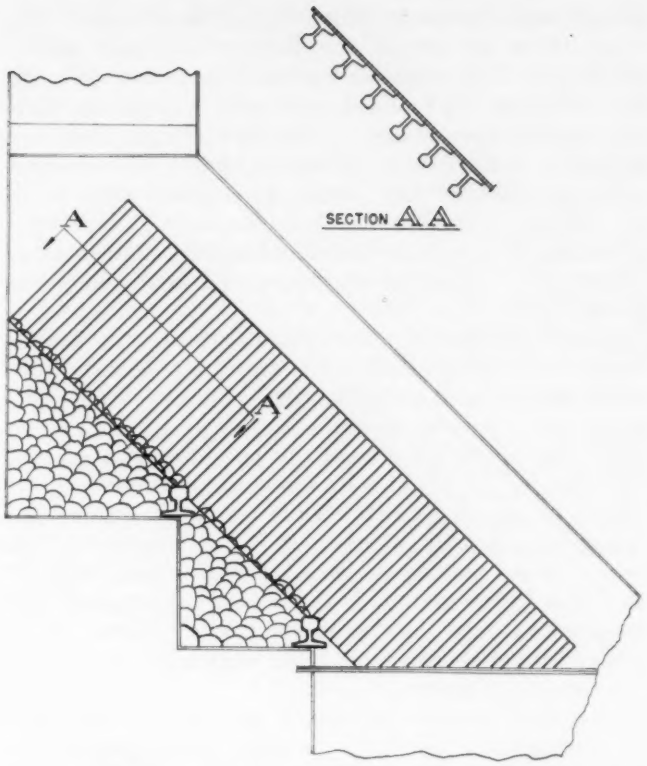



**Figure 4 — Chutes are lined with hard material to resist the abrasion of ore and sinter.**

Conveyors outside of buildings may be in covered or open galleries. Plants in favorable climate areas successfully use belt covers only. Plants located in the northern United States usually have covered galleries. In some of these it has been found essential to have space heaters, since serious spills may occur when conveyors are stopped full of material in cold weather and started later after the material has frozen. Clean-up under the return belt is greatly facilitated if a minimum clearance of 24 in. is provided. It is highly desirable to have walkways and safety cable on both sides of conveyors.

One of the most serious problems in materials handling is that of chutes. Chutes are in general a source of grief and sometimes of high maintenance cost. Factors in this problem which require careful design and possibly field correction are size of opening, length, amount and location of wearing-plate surface, and access for repairs. Continued attention to chutes is necessary to prevent build-up or plugging and to halt excessive wear.

Many important design provisions may be made to alleviate the difficulties with chutes. The number and length of chutes should be held to an absolute minimum in the materials flow. The chutes in general should be as short as possible in order to make all transfers as nearly belt-to-belt as possible. In some instances it is practical to introduce an additional mechanical unit, such as a vibrating feeder, in order to eliminate a long or complicated chute. This has been done, for example, in some of the sinter-spillage chutes at the discharge end of the 12-ft sintering machines. The chute slope depends of course upon the moisture, adhesiveness and flow characteristics of the material being conveyed. The slope of dribble chutes should be held at a minimum of 70 degrees.

Whenever the flow characteristics of the material

permit, wear points on chutes should be provided with stone boxes to receive the impact or initial shock. Chutes handling abrasive materials such as coarse ore and sinter should be lined with rails or abrasion-resistant material such as high-chromium cast iron. Rails laid crossways to the flow, as shown in Figure 4, have proved quite satisfactory for linings. Experience with brick of various kinds has not been entirely satisfactory, although there is some cast-alumina brick used successfully under conditions of impact and heat below the sinter breaker.

Almost all sintering plants include track or unloading hoppers of some kind for handling run-of-mine ore, screened ore, and miscellaneous materials from railroad cars or transfer cars into the sintering plant. These unloading hoppers are normally provided with grating over the top, of about 8-in. openings, in order to limit the lump size to that which the conveyor system can adequately handle without spills or plug-ups. This necessitates breaking oversize or frozen lumps and removal of tramp materials. It is easier to dispose of this material at this point even though it requires labor, than at junction points or along walkways throughout the conveying system.

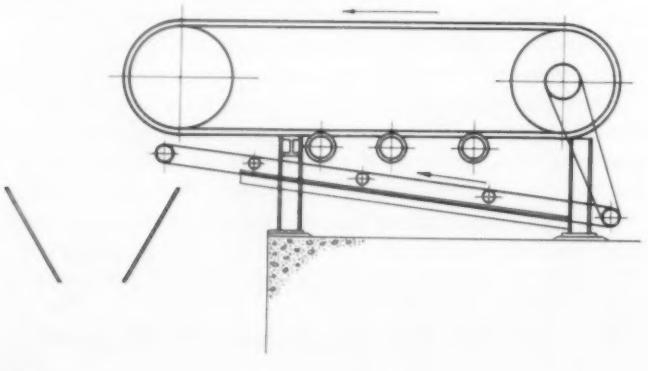
The slope of such hoppers is of course, determined by the tenacity of the materials being handled. In general it is advantageous to relieve sharp valley-angles by inserting half-round sections or flat plates across the acute angles at the intersection of the side plates. Vibrators are frequently used on such hoppers.

The flow of fine ores and other materials from storage bins has in the past been a frequent source of operating difficulty in sintering plants. This is now largely overcome, and the factor chiefly responsible is the use of a minimum 70 degree slope in the cone section of the bins. Even on sticky ore, bins of this construction are self-cleaning.

The flow of finely-ground coke presents many problems in bins. Where the moisture is high, in the range 15 to 25 per cent, the flow of such coke is severely retarded. Measures adopted for overcoming this difficulty have consisted of vibrators on the bin walls and the installation of inflatable rubber panels inside the cone. Both these remedies are successful to a degree, but the best solution to the problem is to trace it back to its source and make the necessary adjustments for insuring a lower moisture-content of the coke.

Several types of feeders are used in the sintering plant, and some of these are a source of considerable operating and maintenance trouble. Apron feeders which may be used at transfer points or in feeding ore-screens usually present a dribble problem. This may be corrected by the installation of a clean-up conveyor underneath, driven from the feeder-drive sprocket shaft, as shown in Figure 5.

**Figure 5 — Clean up conveyors under feeders reduce operating and maintenance problems.**



Pan feeders used to convey hot sinter are a source of costly maintenance. Since the advent of the air sinter-cooler, this type of feeder has little application in sintering plants.

Vibrating feeders or conveyors are extensively used in modern sintering plants. When equipped with stainless-steel, renewable liner-plates, these are very successful for handling most materials except fine ore.

Table feeders which are almost universally used for feeds from storage bins of the components of the sinter mix usually present no operating problems. The wearing surface may be cast-iron segments or some refractory materials. In some designs, a retaining ring may form the outside circumference of the table to minimize wear by establishing a layer of material to act as its own wearing surface.

Screw feeders have limited applications in the sintering plant, such as to feed flue dust and sludge to a pug mill, to transfer dust-collector dust, or to convey spillage out of the feed end of the sintering machine. They are in general subject to undesirable abrasion and high maintenance.

## EQUIPMENT

It is convenient to discuss the equipment in a flow sequence, beginning with screens for raw ore, extending through screens for the sinter product, and covering also the air system and dust collection throughout the plant.

Primary screens for raw ore present several problems. There is usually a bank of these screens for the required capacity and one of the chief problems is to secure adequate distribution both to several screens and across each screen. A successful installation of this kind is one in which there is a surge hopper above the bank of screens, fed by a reciprocating belt, with a vibrating-pan feeder underneath each leg of the surge hopper feeding one screen, as shown in Figure 6. The reciprocating belt distributes material uniformly to the several screens, and it may be adjusted by stops to delivery material to any set of adjacent screens. The 42-in. vibrating-pan feeder underneath the hopper leg serves to feed a 6-ft-wide screen. If the ore screens are fed by chute, it is sometimes necessary to provide a retarding device in order to prevent lumps from bouncing down across the deck. It is common to have the top deck surrounded by protective screen to prevent injury to personnel.

Coke rod-mills are subject to problems of a design and operating nature. Feeding the rod mill may be done by chute or by screw feeder. The chute feeder sometimes requires air lancing to prevent plug-up. The screw feeder is subject to wear. Capacity of the rod mill is severely restricted at coke moistures higher than about 15 per cent. One expedient has been to blow air through the rod mill and thereby prevent condensation of moisture within the mill. The best solution is to trace the source of high moisture, and reduce it if possible. This may mean changes in coke-quenching practice, rejection of fine coke-plant screenings, or even

covering railroad cars to keep off rain.

Skip hoists for coke are used in some plants to take the ground coke from the rod mill to a storage bin. These are the source of high maintenance cost under their usual severe service conditions. Their replacement by a belt-conveyor system is highly desirable. Bucket conveyors are sometimes considered for the service, although they are similarly undesirable from a maintenance-cost standpoint.

Mixing units in sintering plants take several forms. Still used are the double-shaft trough-type pug mills which are installed in pairs, one working at a time. These are alternated once every week to three weeks for removal and repair of the paddle-shaft assembly. These mills, when provided with curved bottoms, do not plug up as the mills of older design used to do, but the wear on the paddle blades is still severe. It is common to use nickel-chromium white cast-iron for the paddles, although tramp material in the sinter mix will break such paddles. The best material from a service standpoint is tungsten-carbide-tipping for the blades.

The drum-type pug mill is used as a mixer in many sintering plants. The paddle blades in this mill are subject to much less wear than those in the double-shaft trough-type pug mill. Another maintenance problem on these mills, however, is the seal at the feed end between the stationary-chute plate and the rotating drum.

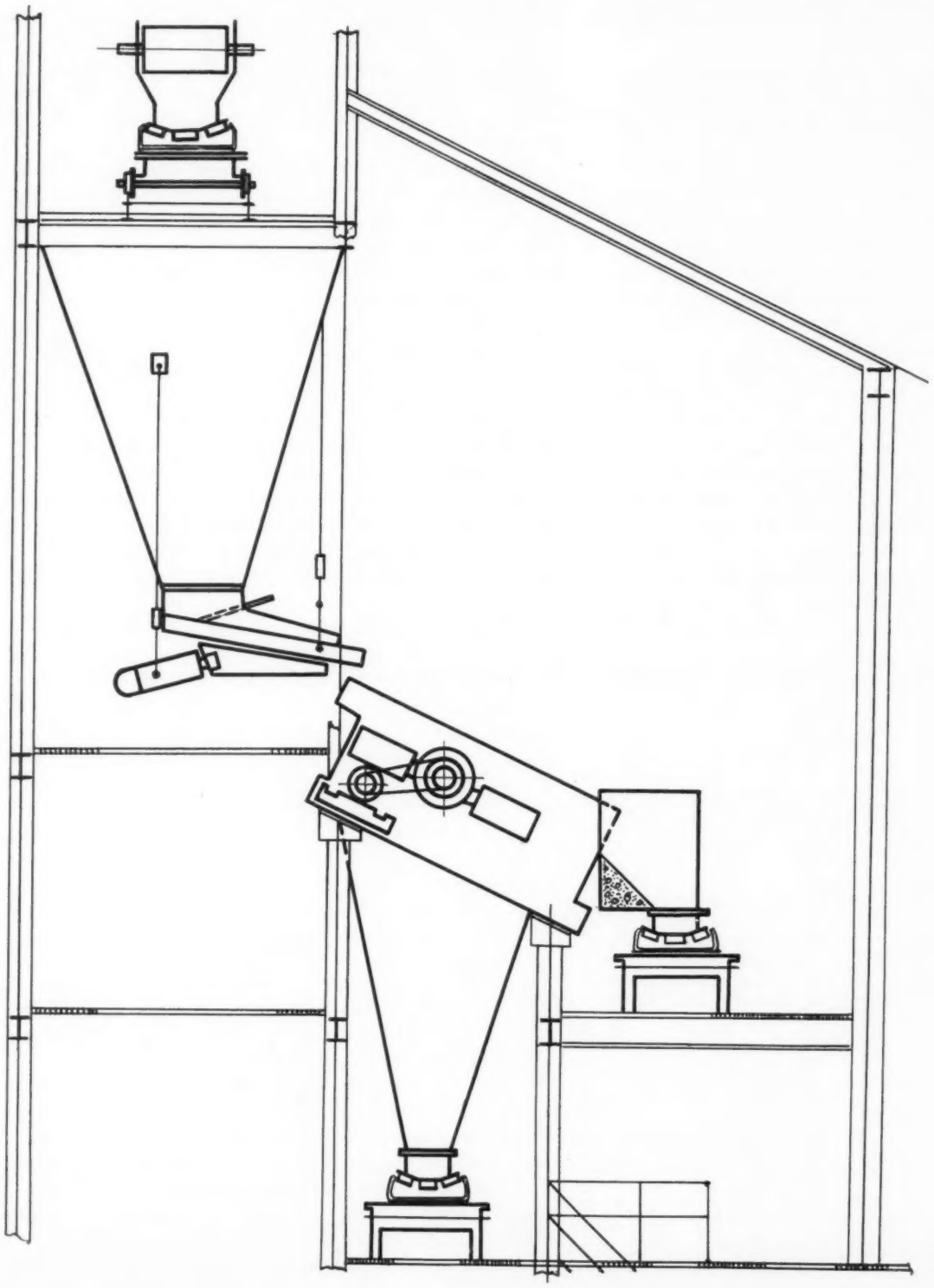


**Figure 6 — Uniform distribution of raw ore is handled by reciprocating belts and vibrating pan feeders.**

In recent installations the feed end of the drum pug mill has been raised, largely eliminating the need for a seal, and further enabling the drum pug mill to act as a balling drum.

Large balling-drums used in sintering plants are designed along the same line as pelletizing balling-drums used for the preparation of taconite-concentrate pellets. These include a reciprocating cutter-bar mechanism, but the cutter bars are not used when installed. It seems sufficient to maintain a rough surface of ore within the drum. This is accomplished in one plant by installing angles on the surface of the drum so that the ore builds up a coating. Mechanically, such a large balling-drum may be subject to rather severe vibration, as has been mentioned before. This may require additional bracing to the structure or the inclusion of a large weight of concrete in the structure.

The method of feeding the sinter mix onto the sintering machine may not be recognized as a trouble spot although it actually may be one. It is important that this equipment maintain the mix in a highly-permeable state and that it distribute the mix uniformly without segregation on the machine so that sinter can be made at a fast rate. There are several successful methods of doing this, all of which are superior to the old swinging-spout. Recent successful installations include vibrating slotted-pan feeder, pivoted oscillating-conveyor, and the roll feeder surmounted by surge hopper and reciprocating belt, as illustrated in Figure 7.

Modern sinter practice requires two feeds. The first, known as a hearth layer, is composed of cold-screened sinter, approximately $\frac{3}{8}$ in. x $\frac{3}{4}$ in. This material must be evenly distributed across the grates at a depth of about 1 to $1\frac{1}{2}$ in. This can be accomplished without a feeder mechanism by an installation of surge hopper having a cut-off gate. Such an installation requires negligible maintenance.

The sintering machine itself is usually the item of least concern as a trouble spot in the sintering plant. Its structural support is an important feature, and it is preferable in the machine framing to have a support frame for every windbox.

The formerly very-troublesome wearing of the faces of pallets has been corrected in newly-designed machines. This is accomplished in one machine by the use of transition guides at the four points where curved track joins straight track. These transition guides serve to make the points of contact of pallets travel a circular path without rubbing action, while the wheels travel an irregular cam path.

Provisions in the machine design for heat expansion are very important. In the design illustrated in Figure 8, the windboxes are bolted rigidly together as a unit and are fastened to the framework only at their midpoint, so that lateral expansion is possible toward both ends. Expansion provisions must also be included in the downcomers and collector main. Two recent installations have been made, as shown in Figure 9, in which stainless-steel flexible bellows have been provided in the downcomers, allowing expansion in all three directions.

Adjustment to the discharge-end framing of the sintering machine as illustrated in Figure 10, is necessary to control the gap in the pallet train. This gap closes somewhat from the cold to the hot condition and it is difficult to predict the final position.

Grate bars on some sintering machines are a source of operating difficulty and expense. The almost universal use of malleable iron for grate bars is continuing, but the most recent installations use alloy bars of various composition, such as 25 to 30 per cent chrome, 1 to 2 per cent nickel. The consumption of alloy grate bars in one plant is less than 0.04 lb per ton of sinter. The warpage of grate bars has also been a problem at many plants. This has been corrected in two different ways, both of which are successful. Some machines use short grate bars about $10\frac{1}{2}$ in. long, and some machines use heavy grate bars of about 2-in. cross section.

Side plates of the sintering machine seem to suffer

**Figure 7 — Feeding of the sinter mix onto the sintering machine must be done uniformly and quickly for proper plant operation.**

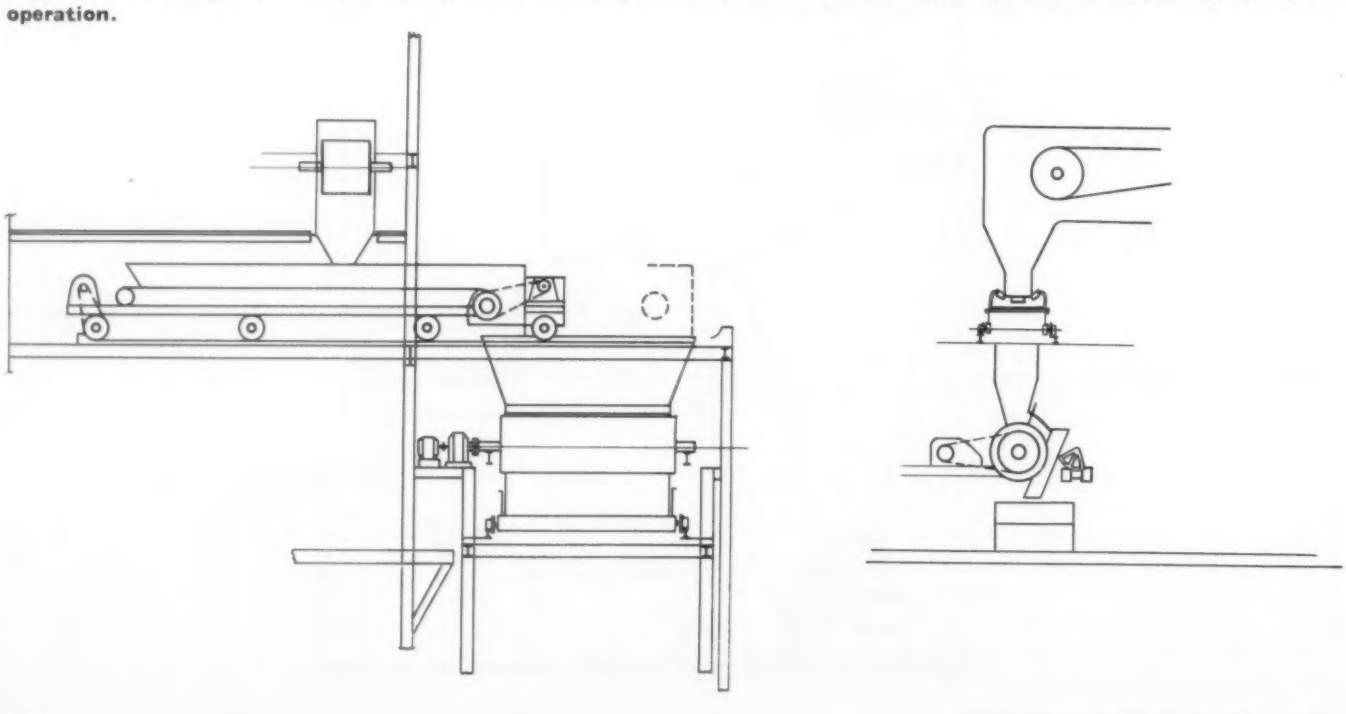


**Figure 8 — Installation of windboxes to provide for heat expansion is a factor in successful sintering.**

**Figure 9 — Stainless steel bellows allow expansion of downcomers.**

more in service on those machines having a hooded-type ignition furnace. The parts of the side plates exposed to radiation and flame impingement from the furnace are sometimes burned and cracked.

Spillage of sinter fines and raw mix at the feed end of the sintering machine is carried away by a screw conveyor or a belt conveyor. Both offer some disadvantages. The screw conveyor requires maintenance and may break from tramp material. The belt conveyor deteriorates from heat carried downward from the ignition furnace.

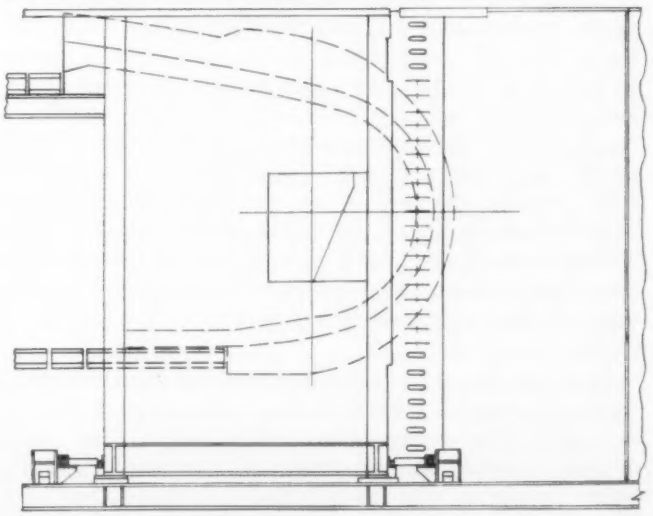
The ignition furnace of the sintering plant may be a source of high maintenance cost. Furnaces of the torch-type having a row of flame-impingement burners across the bed are not subject to significant maintenance cost. However, the larger, hooded furnaces, installed on recent machines to accommodate higher machine speeds and limed mixes, are lined with refractory which requires more-or-less frequent repair and replacement. A good life for a furnace lining of this type seems to be six months, and many plants experience much shorter life. At one plant a problem of sticking of spattered material on the sidewalls of the ignition furnace has been largely overcome by replacing the sidewalls of the furnace with basic brick. The life of the lining is of course greatly influenced by the operating conditions of the ignition furnace. Where the gas consumption is low, the furnace lining may last indefinitely. Where large amounts of gas are being burned, it is important to maintain close control on the gas flow. This is accomplished by automatic control triggered by a radiation pyrometer which is sighted within the furnace.

Sinter discharged from a sintering machine in a modern sintering plant strikes first a crash deck, then passes through a breaker and is then screened over a vibrating hot-sinter screen. All these items are subject to heavy wear and frequent maintenance attention. The crash deck is commonly made of heavy rails set flange to flange. Sides of this chute may be lined with silicon-carbide brick or in some cases with abrasion-resistant plate.

The sinter-breaker teeth and the breaker bars are subject to abrasive wear. Successful materials used at these points include several types of hard-surface weld. Some breakers are provided with solid wheels, which make it necessary to conduct maintenance in place. It is possible on the down-day of the plant to send welders into the chute to replace the hard-surface material. Other breakers are provided with replaceable teeth. Bolts used in sinter breakers to hold removable teeth require constant attention, since both steel and high-tensile bolts tend to loosen with the heat. The shafts of some breakers are water-cooled providing an added safety factor in the design.

The vibrating hot-sinter screen represents a much-advanced choice of equipment over the former universally-used stationary grizzly. However, its service is severe and its maintenance is higher than that of a stationary grizzly. It is important that the hot-sinter screen be of extra-heavy design. The successful hot-sinter screens operate at a 5 degree slope, so that only one layer of sinter remains on the screen and the heat from the sinter does not have an opportunity to soak into the screen. Both the drive unit and the screen frame are water-cooled. The drive unit may be located either above or below the screen, although the location below and behind the screen is preferable since it keeps the drive unit away from the heat and dust. The screen surface of grizzly construction should be designed to permit varying the width of openings when desired. It is made of hardened cast alloy-steel. Special provisions are needed in the plant layout to permit maintenance on the hot-sinter screens. One such provision is for carriage mounting which allows the use of a spare screen, permitting adjustments and repairs to be made without plant shutdown.

**Figure 10 — The gap in the pallet train is adjusted by adjustment of the discharge end framing.**



Sinter coolers offer their own trouble spots. Many of the straight-line sinter coolers have suffered from spillage of fine sinter. Some of these installations have been so troublesome that mechanized methods of disposing of the sinter spillage were necessary. In the more recent designs, small conveyor belts are provided under the cooler to take away any dust. This problem is best solved at the source, which is the design of the cooler grate-surface and the carrying mechanism. Even when there seems to be no possibility for sinter to spill down through, it is necessary to provide spillage chutes for occasional dust which escapes.

Some of the induced-draft sinter coolers have suffered from severe abrasion of the fans. This trouble is not present when the coolers are forced-draft and the fans operate on clean cold air.

Cold sinter screens are subject to severe abrasion. The best solution so far found has been to arrange for a heavy grizzly upper-deck and, if the screen is double-deck, a grizzly lower-deck or a rod deck. The grizzly bars are made of cast manganese-steel. Maintenance on the cold sinter screen requires provision for bypassing or changing to a second screen. Parallel screens may be installed, with one as a spare, or two screens may be mounted on a carriage so that one can be in service and one in the repair position all the time. With such an arrangement a screen change can be made in from three to five minutes.

Some thickener and sludge-filter installations in sintering plants have been highly troublesome. The design of the thickener and filter is beyond the scope of this paper. In handling the filter cake from the filter into the sinter mix it is important to provide for the highly-sticky nature of the filter cake. It is not advisable, for example, to provide a surge hopper in the transfer points of conveyors handling the filter cake. The filter cake is advantageously placed on top of other materials on a belt, or mixed with hot dust through a pug mill.

The main sintering fan, when properly engineered, is a highly-reliable piece of equipment. There have been a few recent difficulties with sintering fans. One of these has been the loss of liner plates within the fan housing. This is to be solved by the use of countersunk bolts replacing stud welding of the liner plates.

The chief maintenance item with the sintering fan may be the wear on the impeller blades. Most of the sintering fans in use in the United States provide for ready replacement of the impeller blades with flat plate. It is not uncommon for sintering-fan impellers to have a life of from two to ten years. The life of impellers may be markedly improved by improvements in the dust collection in the waste gas. A dramatic example of the importance of dust collecting on impeller life was provided by the recent experience in one large sintering plant, where the valves of the primary dust-collectors stuck open for a short period of time and the result was a loss of the sintering-fan impeller less than two months after inspection had shown it to be in perfect shape.

In a few recent sintering plants it has been necessary to make special provisions for elimination of noise annoying the surrounding community. This noise originated with the air flow and the fan. Measures taken included the installation of sound-absorbent panels within the fan breeching.

Dust in a sintering plant is the source of many operating difficulties. The chief producing points of dust are: (1) the exhaust-gas stream, (2) the discharge end of the sintering machine, sinter-breaker, and hot screen area, (3) the hot-returns feeder, (4) the discharge end of the cooler, and (5) the cold-sinter screens.

Dust collection from the exhaust-gas stream starts in the collector main which is usually provided with settling hoppers for almost its full length. One of the sources of disruption of the dust-collection efficiency of the exhaust-gas system is the opening of dust valves on these hoppers. These valves are commonly flapper valves which are counterweighted and which open periodically to discharge dust, but which allow air to rush into the collecting main and disturb any dust-settling taking place. One remedy for this situation has been to provide double-acting motor-operated valves on these discharge points. These valves are provided with a "dutchman" section between the two flappers so that a substantial amount of dust can be retained. In installing them it is equally important to provide several holes for poking out the piping and settling hoppers manually. These double-acting valves are not without their own troubles of maintenance, but their use is well justified from the standpoint of saving air and promoting more efficient dust collection. Improvement is called for in the ruggedness of design of the double-acting valve.

Upstream from the fan, cyclone-type dust collectors are almost universally used. The efficiency of these collectors is greatly improved when they have double-acting motor-operated valves at their discharge

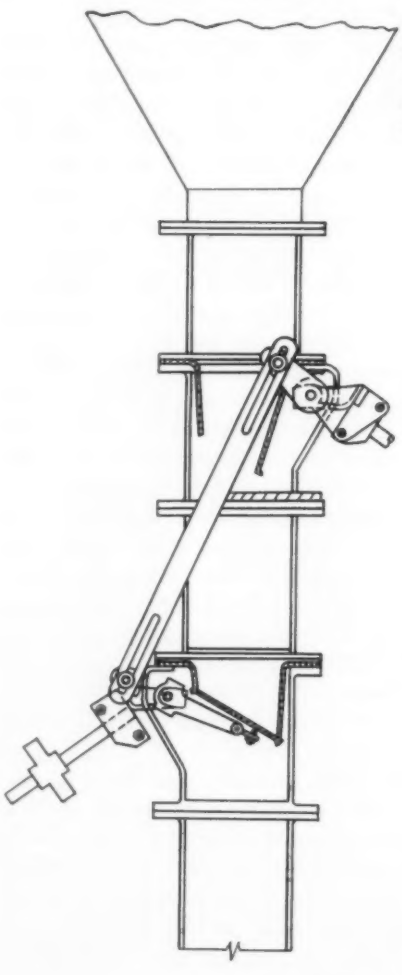


**Figure 11 — Double acting motor-operated valves maintain the efficiency of cyclone type dust collectors.**

points, as illustrated in Figure 11. Dust-collection efficiencies of some 94 per cent of total dust are being attained with large-diameter cyclone collectors of this type. For lining these cyclone dust-collectors, silicon-carbide brick gives an excellent service life. Its cost of several times that of paving brick can be justified. A combination lining of paving brick with silicon carbide at wear points is the most economical solution to the problem.

Electrostatic precipitators have been installed on the main gas-stream in several sintering plants. These present their own unique sources of trouble. Discharge of dust from the bottom of precipitators is troublesome, because the dust collected may vary in consistency all the way from fine talcum powder to wet sludge. An arrangement of flat bottom and drag scapers has been the best solution to this problem. The most serious general trouble with precipitators seems to be the corrosion to which they are subjected when the gas temperature is low and when corrosive agents such as chlorides are present in the gas stream. The condensation and corrosion problems of the precipitator are related to the sintering conditions on the sintering machine and the infiltration of air in the system. If it is possible to keep the gas temperature at 250 to 350 F, then there are no serious problems of this nature. In order to aid in this direction some installations have insulation covering the duct work and precipitators along with steam tracing.

Collection of dust at the discharge end of the sintering machine, where the sinter cake falls from the machine and passes through the sinter breaker and then across the hot screen, is highly important from the standpoint of plant housekeeping. The first type of equipment used here was the multiple-tube-type dry dust-collector. This has a high efficiency for relatively large-diameter dust, but the dust generated at this point seems to have a high proportion of very fine particles in the micron range. Therefore, although operating at rated efficiency, these units frequently pour forth dust from the exhaust stack. Furthermore, it is necessary to be generous with the design volume of these units in order to take care of the many points where dust can leak out of the system.

Some recent installations have successfully provided hydrostatic dust-collectors for this service. These units wash the gas by impingement in a bath of water and attain much higher efficiency on the fine particulate matter. The sludge is piped to thickeners. It is important to be generous with the size of the effluent piping.

## PROCESS AND OPERATION

The process aspects of the sintering plant present many trouble spots which are recognized, but which sometimes have no ready solution. The importance of proper proportioning of materials, regularity of flow of materials, and maximum permeability of the sinter mix as fed to the sintering machine are well recognized in principle, but there have been many griefs associated with their reduction to practice. The automatic proportioning of feed materials, for example, must be balanced against the additional maintenance which it generates on the materials-handling equipment. Some sintering plants have almost insurmountable difficulties in maintaining weighing equipment and instruments. Such conditions are certainly amenable to correction and efforts are being expended in that direction on several fronts. It is still unfortunately common to see a sintering machine operate with an uneven burning condition evident at the discharge end. This is the cumulative result of improper feed proportioning, mix preparation, air flow and the other aspects of process operation. There are no single solutions to these problems, and to surmount them requires exercise of the highest engineering and operating ingenuity.

Among the operating troubles of sintering-plant, which are also common to plants of other kind, are failures or irregularities in water pressure, gas pressure, and power supply.

It is only fair to record that operating forces themselves in new sintering plants have been one of the major sources of trouble. The capabilities of men on the operating force makes all the difference in the world in the smoothness and effectiveness of the operation. As a further comment, the practice of taking seasoned men from an old sintering plant to a new larger one has not proved as successful as might be expected. The older men do not seem able readily to adapt their experience to the greater operating requirements of the new larger plant.

Of general importance in the operation of a sintering plant is its schedule of maintenance. As a matter of fact, the entire time of a sintering-plant operator may well be devoted to problems of maintenance. The following are some of the successful practices evolved, which are peculiar to individual plant situations, the availability of forces and therefore are not subject to generalization:

1. Maintenance of conveying system and materials handling outside the sintering plant building throughout the week rather than on the sintering plant down-day.
2. Concentration of forces within the sintering plant building on the down-turn.
3. Continuous inspection and minor repairs for preventive maintenance, with responsible men taking turns at various parts of the plant.
4. Advance planning of down-turn work.

## SUMMARY

This has of necessity been a rather dismal recital of difficulties and troubles associated with sintering plants. At face value it might tend to discourage managers from ever undertaking to build them. On the other hand, the trouble spots are a continuing challenge to those responsible for sintering plant design and operation. There are many opportunities for improvement. Sintering plants have come a long way from the early days. They have even come a long way from their condition of a very few years ago. The attention which they are receiving nowadays is a good sign that many of the present troubles will be solved. The best assurance of a good sintering plant is to have the best talent possible on the job, in engineering, in construction, in operation, and in maintenance. Let us hope that a man writing on this subject a few years hence will not have to comment wryly, as one man recently did, that areas of difficulty in sintering plants would encompass "the entire plant." ▲

*. . . . Kaiser Steel exemplifies the application of preparation and cooperation in relocation of its hot strip mill finishing stands. . . .*

by LAWRENCE L. FRERET, Chief Project Engineer, Kaiser Engineers, Div. of Henry J. Kaiser Co., Oakland, Calif.

# Kaiser's new hot strip mill

TO MEET the West's growing need for steel, the Kaiser Steel Corp. in 1956 launched the largest expansion program in its history. The program was of such magnitude that upon its completion, Kaiser Steel was to rank ninth in the nation in capacity.

The total facilities to be added, shown shaded in Figure 1 were: coke ovens, a blast furnace, an L-D process plant, a universal slabbing mill, a 4-high reversing plate mill, an 86-in. continuous hot strip mill and additional finishing facilities.

This paper covers one of the most important facets of the $214,000,000 expansion program: the dismantling and moving of the finishing end of an existing hot strip mill from its old location in the plate mill building to a new site in the new continuous hot strip mill building three-fourths of a mile away. Here it was to become the finishing end of a modern-new-full continuous mill.

The move, accomplished in 33 days, necessitated a vast amount of preplanning. It was a major engineering and construction accomplishment.

Prior to the expansion program Kaiser was producing coils on a combination semi-continuous hot strip and plate mill, the full six-stand finishing end of which had been in operation for approximately ten years. This mill not only produced coils, but also plates which were taken off between the intermediate reversing rougher and the finishing stands. With the installation of new strip and sheet finishing capacity, additional coils would be required over and above the capacity of the old mill. It was, therefore, decided to construct a new full continuous hot strip mill for the production of coils, and to modify the old breakdown mill and intermediate rougher for the production of plate only.

The new mill was to consist of three slab heating furnaces, a six-stand roughing train and a six-stand finishing train complete with coilers.

The roughing train, complete with motors, controls and switchgear, was to be purchased new. In the case of the finishing end, there were two sources from which to obtain the equipment. An entirely new six-stand finishing train could be provided, or the existing finishing end of the semi-continuous hot strip mill could be relocated.

The second possibility proved to be extremely interesting, not only because of possible economical ad-

vantages, but also because the equipment would soon be available for removal under planned modifications to the plate mill. Economic studies justified the relocation of the old mill. It is estimated that this decision resulted in a cost reduction of approximately $13,000,000.

Having reached this decision, a program of planning and scheduling was organized which would make the move possible in the most efficient manner. A committee was formed comprised of representatives from Kaiser steel and our engineering staff whose duty it was to develop the planning and scheduling through various meetings with the proper operating departments at Fontana and with the vendors whose equipment was involved.

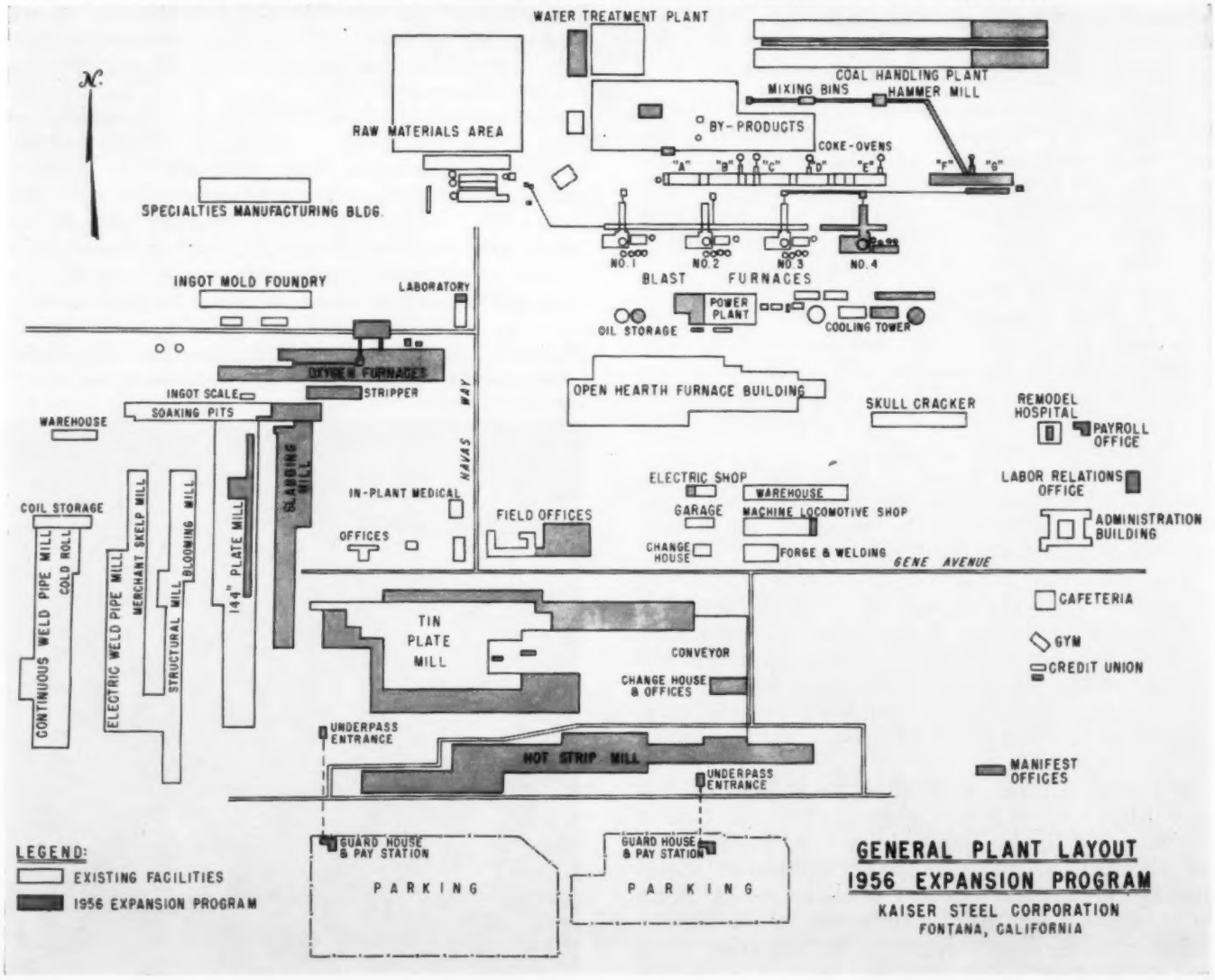
It was realized at the start that the relocation of the facility involved much more than merely the dismantling, transportation and re-erection of the equipment. Actually the problem proved most complex because of the production tie-ins between the equipment to be moved, the plate mill which was to remain, and the other presently operating plate, sheet and strip finishing facilities which were using products from the existing mill.

Eight major requirements were forecast, all of which would have to be successfully met to accomplish the move without affecting the production of any of the dependent facilities. What were these requirements? They were:

1. An accurate forecast of the shutdown period required with the goal of minimizing downtime with its loss of hot strip production, and layoff of operating personnel.
2. An adequate stockpile of coils to supply market demands throughout the shutdown period and the provision of areas for storage.
3. No interruption of production on adjacent facilities.
4. A review to determine equipment to be revised, repaired, discarded or relocated.
5. Provision of adequate facilities for revisions and repairs during the shutdown period.
6. Provision of adequate crane facilities, tools and transportation equipment.
7. Provision of ready access to the crowded areas around the equipment.
8. Development of manpower and supervisory requirements for all phases of the project.

The actual time of shutdown could not be forecast very far in advance. This crucial time depended upon many things such as completion of the foundations for the new mill, receipt of all materials required, and the ability of the existing mill to produce a predetermined stockpile of coils for the finishing facilities which would

**Figure 1 — The shaded areas indicated the magnitude of the expansion program at the Fontana plant.**



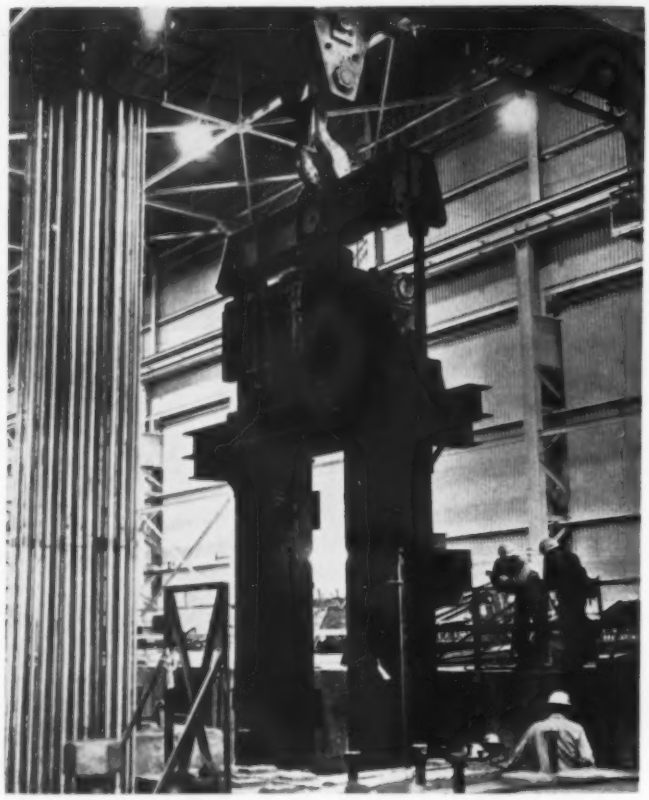


**Figure 2 — The first housing to be re-installed is lowered into position using a special handling device.**

operate during the relocation period.

Prior to the relocation, approximately 60,000 tons of hot rolled coils were produced on the old mill and stockpiled for hot strip and sheet finishing, pickled and oiled products, cold rolled coils and tin mill bands. This material was stored in every conceivable sq ft of unused floor space, both under cover and in the open, since at that period of the year it does not rain in California.

Close scheduling of the cranes was necessary to insure uninterrupted operation of the adjoining plate mill. This meant that the available crane time would have to be utilized both for the removal and loading of the components of the six-stand finishing train and in servicing the production needs of the existing plate mill facilities which would continue to operate.

The first step in planning the move was to secure a complete set of records, both mechanical and electrical, covering the facilities to be relocated some 1500 separate drawings were involved.

The second step was to compile a complete inventory of the exact items of equipment in use in the operating mill which would have to be dismantled, moved and re-erected. Fortunately some of the existing equipment was not required for the product being rolled before relocation. During maintenance shutdown periods these pieces were removed to provide more working room for the final relocation.

A typical problem confronting the committee concerned the removal and subsequent relocation time of the bases for the mill drive motors. It was not considered feasible to relocate all motor bases in the scheduled 33 days inasmuch as they would be the last items to be removed and the first to be reinstalled. The decision was to purchase three new bases and install these well ahead of the actual relocation. As each of the first three motors were removed and reinstalled on the new bases, their old bases were to be relocated to receive the three remaining motors. A similar problem applied to the mill shoes. Subsequent studies revealed that the shoes would not be reusable after removal, and they were purchased new and installed prior to relocation.

One prime consideration in the move was to determine the heaviest components into which the various items of equipment would have to be broken in order to be within capacity of the overhead cranes, as well as the transportation equipment. All major components of the equipment were match-marked in large painted numbers for ease of identification and reassembling. All connections to be broken were match-marked with chisel points. Large arrows were painted on component parts so that, in the relocated position, they would all point south.

Identifying item numbers, in color code by system, were painted on all the utility piping and equipment. A piping inventory was then made showing the size, manufacturer, face-to-face dimensions and disposition of each item. Where this inventory indicated that an item could be reused with or without repair; it was so tagged and its identifying number was indicated on the drawings showing the new installation. Photographs were taken to further facilitate the relocation, especially where an array of miscellaneous gages, instruments and tubing were to be moved.

Preliminary studies were made on the methods of loading, transporting and unloading to determine the overhead and truck cranes required and the transporting equipment required.

Detailed layouts were made showing access rights of way, and special lanes for access through the existing mills were designated. Temporary openings in walls were made and temporary bridges installed over pits and other obstructions where required. Temporary tracks were extended into the plate mill so the overhead cranes could load the dismantled equipment directly onto railroad cars in a sequence such that cars nearest

**Figure 3 — Pre-installation of the majority of conduit, wiring and switchgear speeded the finishing stand installation.**

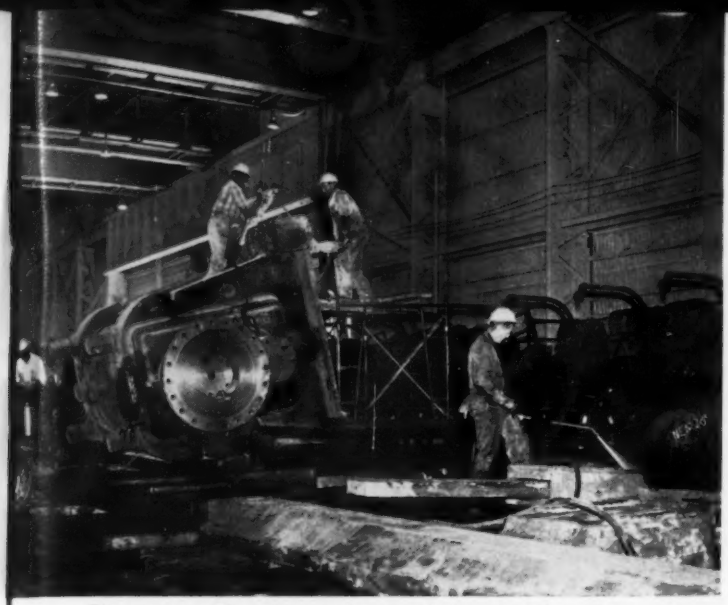


**Figure 4 — Cleaning and reconditioning of equipment was an important part of the expansion program.**

**Figure 5 — Operation of the mill was begun within the planned scheduled time.**

the doors could after loading be switched to the new location during loading of subsequent cars.

Large boxes were made for the storage and transportation of small component parts of each major piece of equipment being relocated. Each box was marked as to contents and final location, and dispatchers were assigned to direct their movements.

The existing equipment was reviewed for items which would require repairs. Where possible repairs were made prior to the relocation. The balance of equipment was repaired during the relocation period.

A thorough study of the small tools, jigs, fixtures and miscellaneous equipment followed, and these were assembled before the relocation began.

The labor needs required careful planning as the manpower schedule indicated that as high as 800 construction workers per shift would be utilized. It was estimated that three shifts per day would be required in the initial stages of dismantling and reinstallation. Prior to the relocation, meetings were held with representatives of the building trade crafts to resolve foreseen jurisdictional problems and make job assignments. As soon as the craft requirements were determined the unions were informed so that they could plan for the manpower required.

Finally an individual detailed work sheet was prepared for each of the major pieces of equipment showing manhours required to disassemble by crafts, mode of transportation, the weights of each major component and a study of the use of overhead and truck cranes.

The summary of these work sheets provided the estimate of required manhours by each craft, indicated the equipment to be used for hauling, showed the total weight of the equipment and the total moving cost and provided the basic information required for scheduling the operation. The summary of the work sheets indicated an estimated expenditure of 230,000 manhours. This information was the basis for a detailed bar schedule for the 33-day relocation period, and covered: (1) dismantling; (2) crane time; (3) transportation; (4) rework and modifications; (5) reinstallation; and (6) tests.

Upon completion of the planning and subsequent approval of the bar schedule, four books were prepared outlining the work and combining all past planning into a concise and usable form that would enable supervision and craft foremen to be aware of all aspects of the relocation and to develop coordination between the crafts.

These books itemized the components of each major piece of equipment, indicating the starting time and scheduled completion date, the dismantling procedure and the crafts and crews involved. All data was cross-indexed and arranged so that work for each shift was indicated and each foreman's assignment spelled out.

As much preparatory work as possible was planned and accomplished while the existing mill was in operation. Damaged parts were repaired; replacement of parts beyond salvage was made; holes were chipped under machinery bases for burning off anchor bolts; jacking holes were provided in foundations under all equipment to facilitate removal. Special cribs were fabricated for the transporting and temporary storage of drive motor rotors, reduction bull gears, etc. To protect the operating electrical equipment from the demolition work, a new wall was erected between the motor room equipment to be removed and the motor room equipment which was to remain. Temporary lines speeded the removal of oil from the existing hydraulic and lubrication systems.

Extensive cleanup was accomplished one week prior to the shutdown and relocation. Four portable steam generators were used to clean the exterior surfaces of

**TABLE I**

**Manpower Requirement Schedules dismantling of equipment**

**Date: April 22, 1958** **2nd Consecutive Day**

| Area | Equipment | Craft | First shift, No. men | Second shift, No. men | Third shift, No. men |
|---|---|---|---|---|---|
| B-C-D | Mill aisle | | | | |
| | Mill stands | Electricians | 12 | 12 | 4 |
| | Chutes, loopers, guides | Millwrights | 30 | 26 | 26 |
| | Lead spindles | Ironworkers | 12 | 12 | 12 |
| | Spindle stands | Pipefitters | 16 | 16 | 16 |
| | Pinion stands | Laborers | 12 | .. | .. |
| | | Carpenters | 6 | 6 | 6 |
| | | Operating engineers | 3 | 3 | 3 |

**TABLE II**

**Major Transportation Equipment**

| | |
|---|---|
| 60 | Flat cars |
| 1 | 150-Ton low-boy |
| 1 | 75-Ton low-boy |
| 4 | 45-Ft semi-trucks |
| 21 | 10-Wheel trucks |
| 2 | 100-Ton overhead cranes |
| 2 | 65-Ton overhead cranes |
| 2 | 60-Ton crawler cranes |
| 5 | 35-Ton truck cranes |

the machinery and piping—pinion stands, mill housings, etc. The cleanup not only aided the identifying and match-marking, but facilitated actual handling of the equipment.

While this work was being done the erection of the new mill building was completed, foundations for all equipment, including that for the finishing train to be relocated had been poured, and the new furnaces and roughing train installed complete with motors, controls and switchgear. This included three new drive motor bases at the finishing train and as many piping, conduit and electrical circuits as possible.

Since all new piping had been pickled after installation, temporary spools had been substituted in those locations that would finally be occupied by relocated pumps, valves and strainers. Bolts and gaskets were sacked, tagged and wired to the new system as close to the place of future use as possible. As much of the electrical work in the new mill as possible was completed. As a result, 95 per cent of the conduit and wire was installed before the relocation began.

At 1:00 AM, April 21, all power with the exception of emergency lighting, overhead cranes and utility power, was cut from the finishing mills. The electricians and pipefitters began to break the connections. Close by, the millwrights began dismantling the mill stands, spindles and drives for movement. By using the previously chipped foundation holes and pockets, anchor bolts were burned off below the equipment, jacks were inserted in the pockets and the items of machinery were broken loose from their foundations. Immediately, the riggers began placing the specially designed lifting jigs on the mill housings and removal and loading started.

The dispatch system for handling transportation took control of the tons of equipment and debris to be removed from the old building and either disposed of it,

**Figure 6 — Finishing stand drive motors and associated switchgear.**

**Figure 7 — New finishing stand foundations were prepared and mill shoes installed prior to production stoppage on the hot strip mill.**

relocated it in the new mill or sent it to the machine shop for repair. Trucks, trailers and railroad cars were ready at a moment's notice. These were loaded on schedule, pulled out of the old mill and shunted out of the way.

All of the equipment was further steam-cleaned, washed with solvent and the machined surfaces cleaned of rust, grease, dust and corrosion before reinstalling. This additional cleaning was performed on the carrier before unloading in order to save an additional handling operation, since it was planned originally to unload directly onto the foundation.

Upon completion of cleaning, equipment was shunted into the new building, unloaded and installed in the sequence previously determined. Within a few hours after dismantling began, the heavier pieces of equipment were being installed in their new location. The mill stands were relocated first, complete with drives. At the same time, motors and controls were connected, circuits rung out, motors bumped for rotation and all necessary revisions and readjustments made. By the time the spindles were ready to be installed the mill train was ready to roll. The flying shear, runout table, sprays, downcoilers, and pilers were next, with the installation following a similar pattern.

The slab furnaces, as well as the complete roughing train, were completed and tested during the relocation period after which the furnaces were dried and brought up to temperature. As a result, when testing was completed on the relocated finishing train, the new 86-in. hot strip mill was ready to run.

Thirty-three days after all power had been turned off at the finishing train of the old semi-continuous mill, it was turned on throughout the new 86-in. continuous mill. The first slab was pushed out of the furnace, successfully rolled and coiled.

This relocation project, made within the planned schedule, was an outstanding accomplishment for both the engineers and the construction people. It indicates what can be done in the steel industry to save time and money by utilizing existing equipment which is considered adequate for re-use as a production tool. It also indicates how detailed planning and a spirit of cooperation between engineer and client can facilitate a project of this nature. ▲

# INDUSTRIAL ULTRASONICS

by A. DIXON
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Metals Joining Section,
Headquarters Manufacturing Laboratory,
Westinghouse Electric Corp.,
East Piltsburgh, Pa.

*. . . . ultrasonics offer unique advantages over conventional industrial methods for soldering, welding, machining and cleaning . . . .*

WHAT is ultrasonics? The term "sonic" relates to the broad field of acoustics and deals with the technology of sound as mechanical waves of energy produced at frequencies above or in the audible range within a substance to perform a useful service. The term "ultrasonics," then, is more specific and relates to sonic or sound waves at frequencies higher than the response of the human ear. In industrial terminology, the term "ultrasonic" is used to describe the application of this energy to the fields of measurement, control, processing and those in other scientific areas.

This article covers some interesting industrial applications with emphasis on particular areas in which the experience of the author predominates; namely, in metals joining work. Four of these areas are becoming well established for industrial use and tools for this work are becoming commercially available These are:

1. Metals joining—soldering, brazing and welding.
2. Cleaning.
3. Machining and cutting.
4. Inspection and nondestructive testing.

Other unique and interesting applications are being developed and used in medical work, sonar detection, electro-plating, deep well drilling and signalling.

## ULTRASONIC SYSTEMS AND HOW THEY WORK

All systems of sonic or ultrasonic application employ three main functional parts. They are: (1) a source of energy which may be either a mechanical generator or electrically produced pulses converted by a device called a transducer into mechanical energy; (2) a medium of energy transmission which may be a solid, liquid or gaseous substance; and (3) the receiver. This would include the work piece, material, or device to effectively utilize that energy. Some familiar examples of mechanical generators to create sound in the audible range are musical instruments, sirens, whistles, or even an auto horn from an impatient motorist. The audible sounds are thus created for the purpose of relaying intelligence. The receiver may be a human ear or, perhaps, a detector, electrical amplifier and alarm system.

The energy source for industrial ultrasonic application, the first functional part of the system, is usually an electronic generator. Electrical pulses are generated at a frequency higher than that of audible sound. The electrical pulses are converted to ultrasonic or mechanical waves by means of a device called a transducer. One type transducer for industrial use employs the magnetostriction principle. This term relates to the property of the transducer material to change its physical dimension when it is electrically magnetized. One common or generally employed material is pure nickel in a laminated core with electrical windings. The application of an electrical pulse causes a small change in physical dimension and when applied at a high frequency rate in the ultrasonic range, produces corresponding mechanical waves at the end face of the transducer core.

These mechanical waves of ultrasonic energy are then transmitted through a metallic or liquid substance for delivery to a work area. This is the second functional part of the system and, one which greatly affects the operating performance. The medium used for energy transmission usually requires careful physical design. This is because sound or ultrasound will travel through

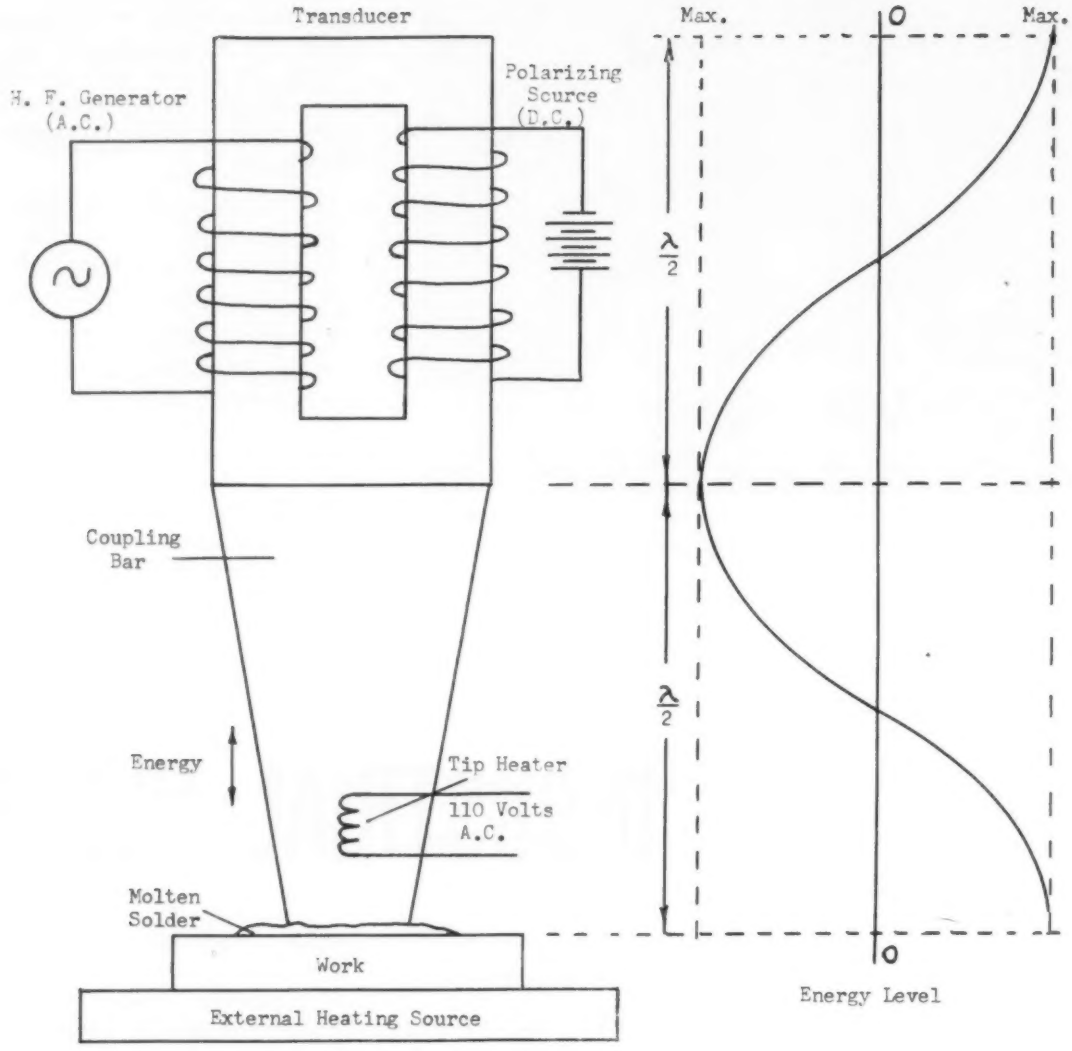


**Figure 1 — Cavitation action in the solder cleans the surface of the metal.**

a substance at a rate of speed depending on its density and modulus of elasticity. This then determines the acoustic velocity factor of the material being used for transmission. An efficient transmission system is so designed that each wave of energy as it travels through the material is delivered to the work area at an instant of maximum energy level. This more active area, known as an energy loop, occurs at the transducer face and at each one-half wave length of the sound wave as it travels from the transducer through a material to the work area. The distance of travel represents some specific physical length or energy path for each pulse at a given frequency, the higher the frequency, the shorter the path. Where the energy is used for metals joining or cutting, it is conducted by means of a metallic coupling bar. For cleaning applications, the ultrasonic energy is conducted through a liquid solution to the surface of the part being cleaned. In general, the vibrating system length including the transducer and coupling device should be the equivalent of an integral number of half wavelengths at the operating frequency.

The third functional part of the system is the receiver or work piece to which the ultrasonic energy and its effect is utilized. This is shown in illustrations of typical metals joining, machining and cleaning systems.

## ULTRASONIC FLUXLESS JOINING

In the applications of tinning, soldering, brazing and welding, the formation of oxides inhibits the free flowing of the metal. This presents a problem area in commercial use of these processes. In standard joining methods, including the fusion processes, control of oxidation is usually achieved by means of an inert atmosphere or by applying a protective flux coating to the parts before joining. Most of the fluxes in commercial use, particularly for joining aluminum and steel are corrosive and generally leave a residue which must be removed after joining. Where a fusion process is used, several objectionable problems are encountered. Some of these are weld spall or spatter, the heat effected weld zone causing embrittlement or limitations in welding near the edge of the material. The ultrasonic method enables the joining of metals and other materials without the use of a corrosive flux or direct fusion and thereby eliminates all these problems but, of course, introduces some of its own problems. The ultrasonic welding process at the present stage of development is more favorably adapted to welding of thin materials.

## ULTRASONIC TINNING AND SOLDERING

In the use of ultrasonic energy for tinning and soldering without flux, the effective removal of oxides depends on the ability of the ultrasonic tool to induce cavitation in the molten alloy on the work surface. Cavitation, by definition in its simplest form, refers to

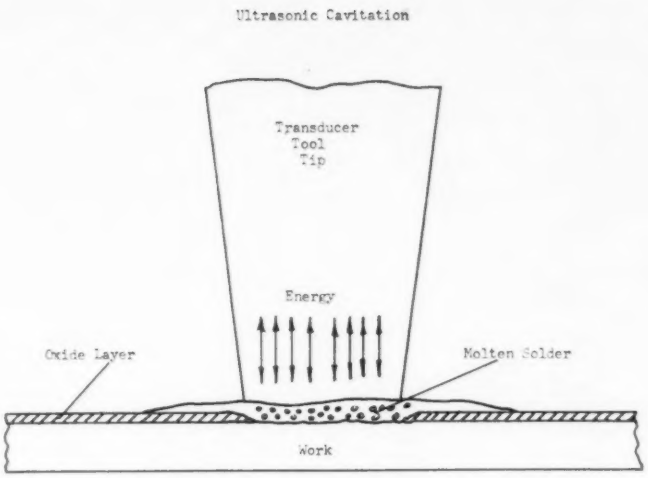


**Figure 2 — Cavitation aids wetting action.**

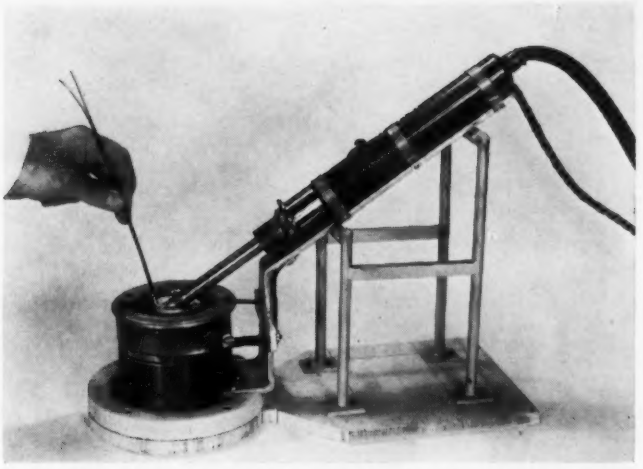

**Figure 3 — A solder bath is used for the tinning of small simple areas.**

action in a liquid medium caused by physical agitation of a cycling nature. In an ultrasonic system, it is manifest in the formation of bubbles having an internal vacuum, and their subsequent collapse as they travel from the energy source.

Figure 1 illustrates schematically an effective system for this use. The cavitating action in the liquid or molten solder causes rapid erosion and removal of oxides from the surface of the work piece. In this manner, wetting action of the solder is achieved before new oxides can form on the parent metal. A frequency range of 10 to 100 kc can be used, with most work being done between 20 and 30 kc. A power level of approximately 250 watts per sq in. of surface area provides a satisfactory level of cavitation for most work. Figure 3 is a magnified view of the work tip to better illustrate the effect of cavitation in a tinning operation.

## TINNING OF SIMPLE SURFACE AREAS — THE ULTRASONIC SOLDERING TRAY

An alternate method for tinning simple surface areas is in the use of a solder bath or tray as shown in Figure 2. In general, tools of this type are limited in usable areas of active energy to provide the required cavitation level. A tray, however, may have one or more transducers for increased area coverage. It has been determined experimentally that the elastic and viscous properties of molten solder will not generally promote cavitation more than $\frac{1}{8}$ in. from the vibratory source, irrespective of power level used. Figure 4 shows schematically the construction of an ultrasonic solder tray. Parts have to be immersed to a depth shown in the active cavitation area to tin effectively.

## ULTRASONIC WIRE SOLDERING

Because of the basic energy coupling requirement, it is significant that an improvement in the coupling system is required in the soldering of a complex area such as a twisted wire assembly. In order to provide effective cavitation level for penetration to the innerfaces of the wires, the concentration of ultrasonic energy can be improved by means of reflector techniques. This is shown schematically in Figure 5. A total combination of concentrated energy from the face of the coupling bar and reflected energy drives the solder through the wires with improved internal penetration. Many different metals can be joined by this technique.

The importance of the galvanic corrosion problem when joining dissimilar metals and alloys should not be overlooked. This problem requires evaluation according to specific application requirements, such as chemical, mechanical, electrical and service temperatures. A production wire soldering tool using the reflector principle joins copper and aluminum coil wires for small

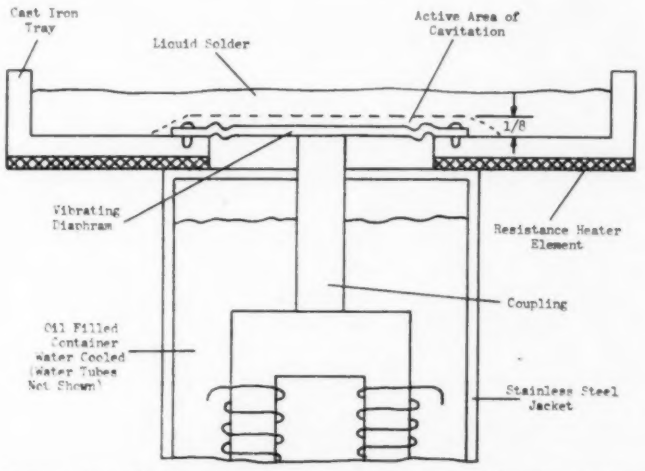


**Figure 4 — Parts must be immersed to within the active area of cavitation for effective tinning.**

**Figure 5 — The use of a reflector increases solder penetration into connection.**

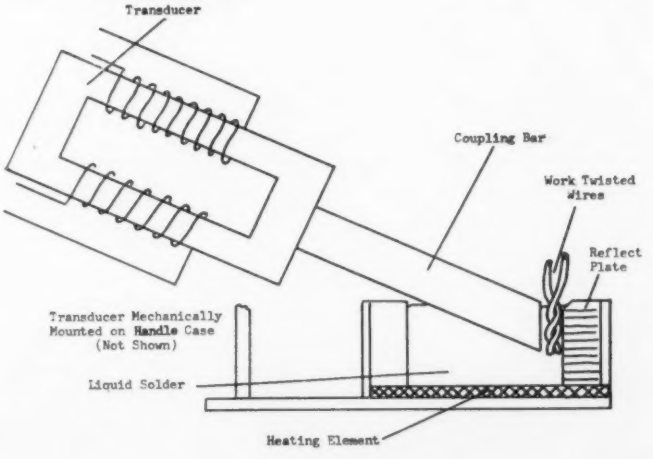

**Figure 6 — Fluxless soldering of many materials is possible through use of a high frequency power source.**

potted transformers. Encapsulating the wire joints often solves the corrosion problem.

### A NEW PROCESS FOR SOLDERING AND TINNING

A new process for sonic tinning has recently been developed by our laboratory to tin and solder a wide variety of materials without the use of flux. This new system, shown in Figure 6, is designed for operation from a 10-kc induction heating motor-generator, power source. The sonic fluxless tinning and soldering method can be installed at a minimum tool cost to employ excess capacity of conventional induction heating generators and run continuously or simultaneously with a standard induction heating operation. This method is effective in tinning of copper, aluminum, steel, cast iron, magnesium and some nonmetal materials. A tinning operation without flux is particularly desirable to eliminate post-cleaning and potential danger of corrosion as a result of flux usage.

### ULTRASONIC BRAZING TOOLS

In comparing ultrasonic brazing with soldering systems, the main difference is in the temperature of the joining alloy used. In general, alloys having a melting temperature below 750 F are classified as low temperature solders. Those having melting temperatures above this point are generally considered brazing alloys. Another significant difference is that oxides form more quickly at the higher temperatures. This problem, however, is not so troublesome with the ultrasonic process because the action of cavitation and subsequent oxide removal is much greater at elevated temperatures for the same power level input.

Figure 7 shows an experimental setup for ultrasonic brazing. The tool is heated by induction coil and temperature controlled using a pyrometer. This method gives precise control to temperature of the brazing alloy which in some applications is necessary. Ultrasonic brazing is successfully used to remove certain organic materials as for example enamel wire insulation simultaneously in the joining operation. Brazing is generally considered only when connections for higher service temperatures are required.

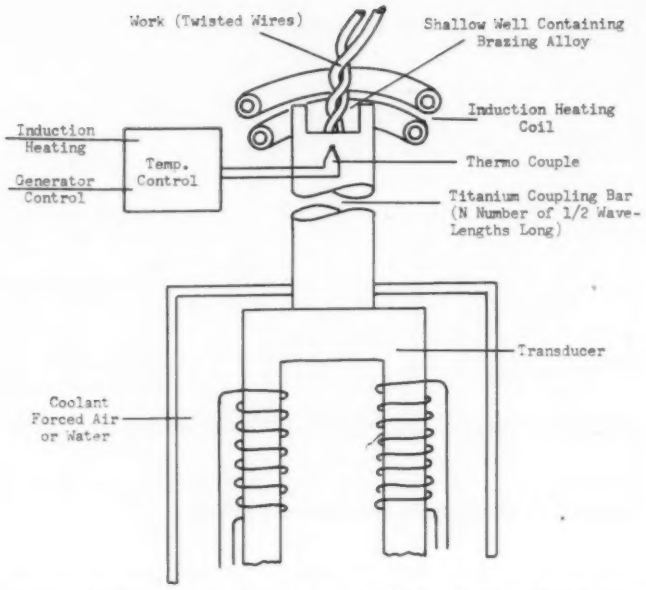


**Figure 7 — Brazing also is accomplished through the use of ultrasonics.**

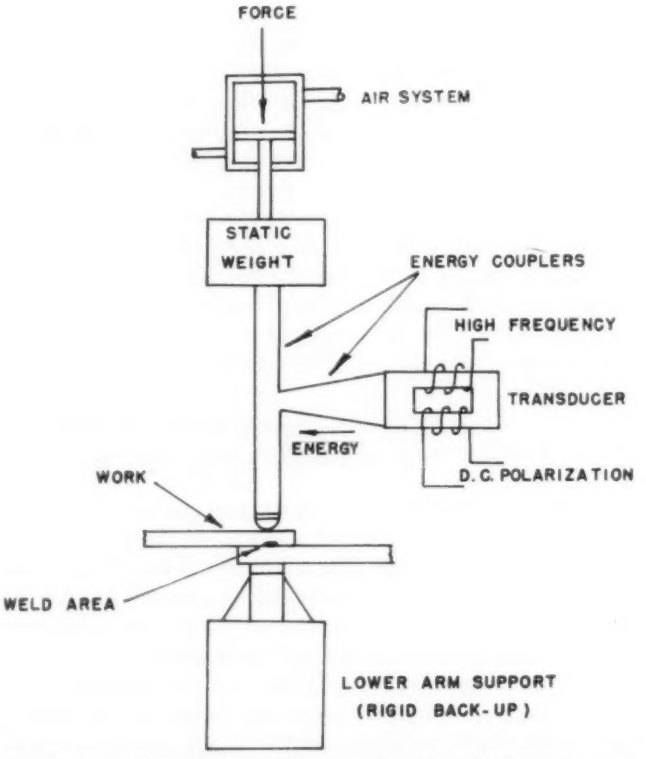


**Figure 8 — Ultrasonic welding makes the joining of many dissimilar materials an economically feasible operation.**

Tools for ultrasonic brazing require the use of erosion resistant materials in the coupling system. A titanium material has better properties for this work than copper or high alloy steels.

### ULTRASONIC WELDING

Figure 8 shows schematically a system for ultrasonic welding. Controlled high-frequency vibrations are transmitted through the vertical electrode to gall the interfaces of the material together, producing a solid phase joint of molecular depth. There is no electric current circulated through the work and no actual fusion of the metal members. Because of this, and some

other unique features, the ultrasonic welding process is helping solve problems in joining of many dissimilar material combinations which are not economically possible to join by other processes. Among other advantages are minimum cleaning requirements of material to be welded, very low thermal power requirements and low welding forces with a minimum surface deformation at the weld joint.

### MACHINING WITH ULTRASONICS

Ultrasonic systems for machining and cutting operate similarly to those for soldering as illustrated in Figure 1. A slurry of abrasive and oil is generally used to aid coupling and to improve cutting efficiency and is applied to the tool face in the same manner as the molten solder alloy in a tinning operation. The tool tip is provided with embossments to localize the cutting action according to requirements of the operation. This method is used for cutting hard and very brittle materials which often cannot be economically done by other methods. An example of this is the use of ultrasonic machining for production cutting of silicon crystals into wafer elements for semi-conductor products.

### ULTRASONIC CLEANING

Ultrasonic cleaning devices utilize the cavitation principle but in general are considered for removal of foreign organic soils, and not primarily for the direct removal of oxides. However, ultrasonic energy is extremely useful for removal of many oxides when it is teamed with an appropriate chemical process. Because cavitation takes place in a less viscous material, namely, some form of cleaning solution, the cavitation level is judged to be less violent in its reaction on the work piece. The general level of agitation in an ultrasonic cleaning bath is designed to give wide and uniform dispersion of energy. This is an advantage because the work parts can be located a considerable distance from the transducer or energy coupler in the cleaning solution.

The process is usually considered for rapid cleaning of intricate parts where accessibility of other cleaning techniques is a problem. A practical example is in cleaning small diameter tubes with inside threaded sections.

### OTHER APPLICATIONS OF IMPORTANCE

We have covered only a limited area in the broad application of ultrasonics. There are several other uses which are of interest.

1. Nondestructive testing where parts can be automatically gaged and checked for internal flaws. Some systems have automatic control features for rejecting defective parts.

2. Electro-plating where the application of ultrasonic energy to an electro-plating bath makes possible a substantial increase in the maximum permissible plating rate with a simultaneous improvement in the quality and uniformity of the plate. Increases in usable current densities of up to thirty times have been reported for small scale experiments. Also, polarization can be decreased in the case of certain plating operations for which it is particularly high.

3. Detection apparatus referred to as sonar devices which operate effectively for underwater detection of elements such as ships, shorelines and water depths The operating principle is similar to that of radar except that reflected ultrasound waves are used instead of electromagnetic waves. The detected signal is governed by the velocity of the ultrasonic wave traveling through water to the target and its reflected return to the receiver.

4. Medical application where the use of highly localized ultrasonic energy is an aid to therapy. The object is to promote blood circulation and influence the removal of unwanted elements in human bone structures. It is also used for surgery in dental work.

5. Signalling—TV manufacturers are marketing a remote control accessory which uses ultrasonic vibrations for program selection. This consists of a small "black box" with no wire connections, having a number of metal bars of tuned lengths. When the operator selects and pushes a button, a small hammer strikes a bar emitting a note of ultrasonic frequency. The signal cannot be heard by the operator, but is picked up by a special microphone at the TV receiver. The signal is amplified according to its specific received frequency and operates a motorized switch, changing the TV channel.

6. High-fidelity sound application—A unique idea is being explored for propagation of high fidelity sound by means of ultrasonic transducers mounted in opposite walls of a room. They both operate at an identical ultrasonic frequency and have a superimposed audio frequency program. When operating, this system produces a demodulation of the audio sound, causing it to appear at the center of the room rather than from a localized loud speaker source.

### SUMMARY

Ultrasonics is in an era of rapid technological advancement, presenting many new and interesting ways of performing a useful service. An increasing number of these applications are being proven practical and economical. In consideration for industrial use, the following conclusions can be made:

1. For metals joining applications, the ultrasonic process offers a highly favorable advantage of being able to join a wide variety of metals without the need for a corrosive flux or direct fusion of the metals.

2. In machining applications, ultrasonics provide a unique tool for cutting very hard and brittle materials which often cannot be economically done by other methods.

3. The use of ultrasonic cleaning is generally justified only for intricate parts or where other cleaning methods are not effective.

4. The ultrasonic process is becoming established as a reliable method for non-destructive industrial testing.

5. The use of ultrasonics in a well designed system presents no known health hazard. Since the human ear mechanism does not respond to frequencies much above 15 kc, the use of equipment at these higher ultrasonic frequencies is virtually noiseless in operation. Tests have been conducted to determine noise level on frequency operation as low as 10 kc and power levels to 1000 watts. It is determined that proper energy coupling will effectively minimize the noise problem to acceptable limits, even at an audio frequency.

In general, the handling of any vibration tool at a point of energy concentration will cause irritation and,

at high frequencies, skin burning. A transducer tool of proper design provides a mechanical mounting which transmits very little of the energy to the hand of the operator. This is possible because the mechanical attachment is made at points of minimum energy or nodal points.

Special precaution should be taken however with the use of cleaning equipment. The bare hands should never be immersed in the cleaning solution with the ultrasonic energy turned on. The deep penetrating effect of the cleaning solution can adversely affect or contaminate the blood stream. Where cleaning equipment is used continuously, provision should be made for expelling any vapor or toxic fumes caused by cleaning solutions. This is particularly necessary where a volatile solution is used.

6. Economic considerations are being greatly influenced by the present high cost for equipment and to some extent, limited availability. This problem should become less significant as the state of the art progresses and the equipment market becomes more competitive.

The rising barometer of industrial and scientific use points to ultrasonics as a growing process to invite and stimulate the interest of research, development and application.

## Discussion

PRESENTED BY

**I. G. ORELLANA, Head, Measurement and Control Div., Electromechanical Research Center, Republic Steel Corp., Cleveland, Ohio**

**A. DIXON, Supervising Engineer, Metals Joining Section, Headquarters Manufacturing Laboratory, Westinghouse Electric Corp., East Pittsburgh, Pa.**

**I. G. Orellana:** I have a question relating to the application of ultrasonics to tinning and inspection. Have you applied the process of ultrasonics to your tinning or brazing or welding, and then further applied it to the inspection of the brazed or welded parts? I have in mind the application of ultrasonics to the measuring of soundness of welds. We make pipe in large sizes and have endeavored to test the electric fusion welds by the use of ultrasonics.

I have another question relating to safety. We have recently had an inquiry from our safety department in evaluating the energy levels that are safe to use in ultrasonics. Do you have any information on this phase of ultrasonics?

**A. Dixon:** We do use ultrasonic inspection quite widely. We have ultrasonic inspection equipment in the laboratory and also in some of our production groups.

In using these techniques, their reliability improves with thorough training of an operator to properly interpret his results. The effectiveness of such inspection techniques depends largely on the competence and degree of training that the operator has had. We have sent several of our technicians to ultrasonic inspection training courses for that purpose.

For tinning and soldering we have been able to get successful results with 200 watts input per sq in. of working area. This power level enables us to get above the threshold of cavitation for tinning and soldering. In other words, below this power level the cavitation is not sufficient for consistency in solder castings. We have not been able to determine any other hazards that might arise from using these tools. The manner of design is important for isolation of high-frequency energy in hand tools. In tools of proper design, very little energy is transmitted to the hand of the operator. In the case of sonic systems operating on the audio frequencies, the effective coupling of the power into the work is more important to utilize the energy locally, rather than to propagate it orally so that it becomes a noise factor. ▲

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# a new electrical circuit for Reversing Dynamic Braking Control of mill type d-c series motors

by K. S. KUKA, Superintendent,
Electrical Engineering & Construction,
M. N. Dastur & Co., Private Ltd.,
Consulting Engineers,
Calcutta, India

*. . . . dynamic braking systems using heavy duty silicon rectifiers offer troublefree, contactorless, long life operation . . . .*

A D-C series motor becomes a self-excited d-c generator, if its series field and the armature are so connected that the voltage across the armature can force current through the series field in the direction of the residual field of the motor when the motor armature is kept rotating in its initial direction of rotation.

Figure 1 indicates the conditions of the connections which must be established if a series motor is required to be connected in a self-regenerative circuit. The diagram shows that when the isolating switches are in positions 1, 3 and 5, the motor operates as a normal d-c motor and the direction of current through armature and the series fields is as indicated by the arrows. When the isolators are changed over to positions 2, 4 and 6, the motor is disconnected from the power lines and is reconnected in a closed circuit over its own field. If the armature still keeps rotating in the same direction, a voltage is generated across the armature commutator brushes because of the small residual field of the motor field system. This small voltage will tend to force a current through the series field. This current is in the direction to increase the motor field, which in turn, generates higher voltage. The process is cumulative and the current increases until it is stabilized at a value proportional to the speed of rotation of the armature

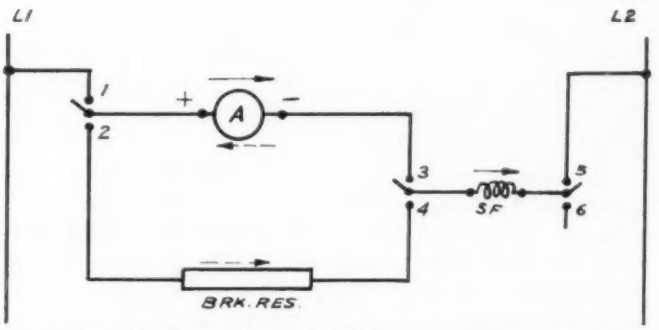


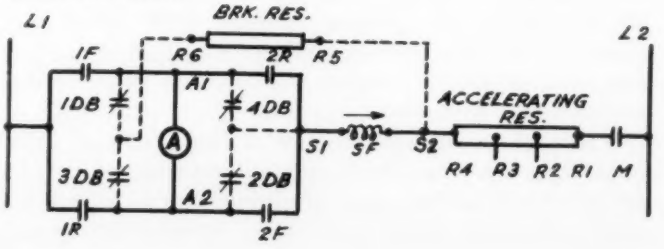

**Figure 1 — Series motor connections as shown are required for a self-regenerative circuit.**

and the resistance in the circuit. The motor thus becomes a self-excited generator, having its own dynamic braking action to the movement of the armature.

For a reversing cycle, to get braking action in either direction, the control circuit has to be arranged such that the armature and the series fields are connected to permit current through the series field in the same direction as during the motoring action. The control has to be designed to give motor dynamic braking action in both the directions.

The well known method of providing dynamic braking of a series motor in both the directions is given in Figure 2. The contactors 1DB, 2DB, 3DB and 4DB are designed as spring-closed contactors which maintain their contacts closed when their coils are not energized. When the coils are energized, the contacts open. The contacts also open when the motor is running.

**Figure 2 — Circuit often used for dynamic braking of a d-c series motor.**



A mechanical cam shaft extending across the four contactors is turned in one or the other direction by two separate electromagnets. One of the electromagnets is energized when the forward direction contactors 1F and 2F are energized, and the cam shaft is turned so that the contactors 1DB and 2DB are locked open by the cams. When the motor is switched off, only the contactors 3DB and 4DB can close. When the motor is running in the foreward direction with A1 terminal positive, current flows through the armature from A1 to A2 and through the series field from S1 to S2. The motor counter voltage is in the direction from A2 to A1. If motor is then switched off, current will flow out of A1, through 4DB, from S1 to S2, through the resistance R5 to R6, through 3DB to A2 and back through the armature to A1. The field is energized in the same direction as when the motor is running, which gives a self-building regenerative braking action.

When the motor is reversed, the cam shaft is rotated to the opposite direction, and the contactors 3DB and 4DB are locked open while 1DB and 2DB are free to close. The motor terminal A2 now becomes positive. Current flows from A2 to the terminal A1, and then through S1 to S2. If the motor is again switched off, current then will flow out of A2, over 2DB through S1 to S2, over the resistance R5-R6, then over 1DB contacts to A1 and back to A2. The field current is again flowing in the correct direction to obtain regenerative braking action.

The circuit in Figure 2 thus gives automatic regenerative braking of a series motor in both the directions of motion whenever the motor is switched off from the line. The regenerative braking action takes place even if the power fails, which is the same thing as the switching off of the motor from the power lines.

The dynamic braking circuit in Figure 2 is often applied on steel mill traveling cranes to provide automatic dynamic braking of the crane long travel motion in case of sudden power failure. The contactors 1DB, 2DB, 3DB and 4DB are so connected that they normally remain energized so that the contacts remain open under normal operation. The crane is stopped in normal service by the so-called plugging service. The dynamic braking service becomes effective only in case of power failure, or when the crane operator wishes to stop the crane motion suddenly by de-energizing the dynamic braking contactors when the motor is switched off from the line.

The dynamic braking action can also be as effectively obtained by distributing the latched-type spring-closed contactors over the motor series field as shown in Figure 3.

The dynamic braking circuit however is not generally adopted as the circuit is complicated and the mechanically latched-type contactors require a good deal of maintenance and give frequent troubles in practice. Because of the above reasons, the dynamic braking circuits have not become popular with steel mill operators and the reversing plugging system of control has been generally adopted for majority of reversing duty services with d-c series motor.

The problem of maintenance of the latched-in type contactors can be easily eliminated by using rectifiers in bridge-circuit in the place of spring-closed contactors. Rectifiers would give a contactless circuit which would

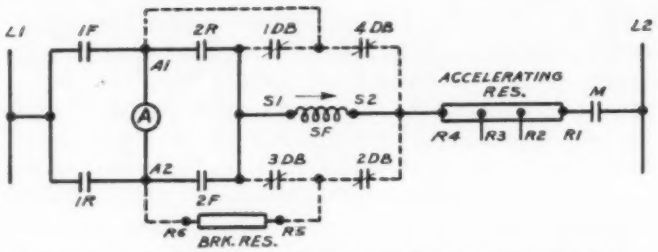



**Figure 3 — Placement of the dynamic braking contactors in the field circuit also produces effective dynamic braking.**

require no maintenance as far as servicing of the control is concerned. Figures 4 and 5 show the connections for the rectifier-operated dynamic braking control. Figure 4 gives the circuit for the armature connections and Figure 5 for the series field connections. It will be observed that in either case, two standard spring-closed contactors are required to close the dynamic braking circuit.

The rectifiers for power circuit for steel mills for crane and heavy duty mill reversing services have not been used because the types of rectifiers so far available were sensitive to high temperature and required special cooling and good space for installation. For constant potential reversing motor service with series motors, the reversing dynamic braking circuits remained complicated as compared to the reversing plugging control and the dynamic braking control for d-c series motors could not become very popular for general steel mill service.

With the advent of the modern silicon rectifiers, which can stand high ambient temperatures and require less space, the rectifier operated dynamic braking circuit can be effectively used with all the advantages of having smooth electrical braking, as is done with mill-type compound motors and shunt motors. With compound and shunt motors, dynamic braking reversing controllers are now used to a greater extent in preference to reversing plugging controls.

For rolling mills auxiliaries for constant potential controls, mill type d-c compound motors are normally

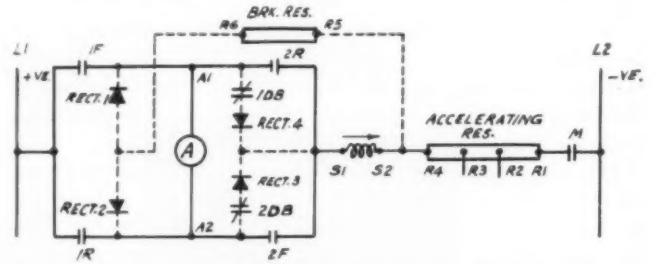
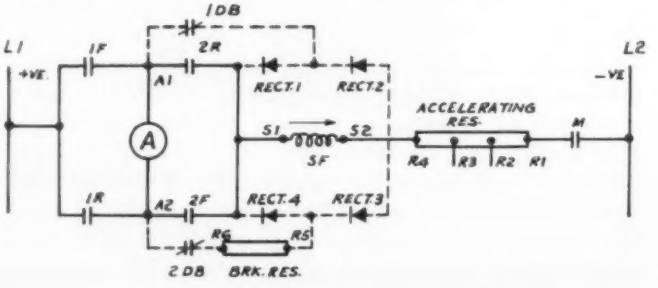



**Figure 4 — Rectifiers can be used to replace dynamic braking contactors in the armature circuit.**

**Figure 5 — Even though rectifiers are used, two spring closed dynamic braking contactors are required in field circuit.**



used because the series motors tend to over-speed on light load and dynamic braking is not easily applied to a series motor, as is done with compound motors with fully excited shunt field.

It is the experience of steel mill electrical men that even with the modern AISE 600 series, class H insulated d-c mill motors, a constantly excited shunt field forms a weak link, and the control needs field-economy and field-failure relay protection, which in turn complicates the control circuit and requires increased maintenance. When electro-mechanical brakes are required for a reversing service, shunt brakes are used in preference to the more robust series brakes, because the series brake tends to drop out at light loads and also drops off each time the master switch is moved through the zero position.

If a control circuit is designed which can give a simple and positive reversing dynamic braking circuit and provide a compounding effect to the series motor to prevent over-speeding on light loads, the simplest and the most robust d-c mill-type series motor can be used for all services where a compound motor is used today. The circuit should also permit the use of d-c series brakes when required. The brake should function in the circuit as a holding brake only, the main braking being affected by the motor dynamic braking action. The circuit should be capable of providing graduated dynamic braking action up to very slow speeds, and should give all the known advantages of a standard reversing plugging control to slow down and reverse the motor quickly and smoothly.

Such a control could replace compound motors for normal constant potential d-c mill auxiliaries and permit d-c series motors to be used as effectively with greater advantages to maintenance. Such a control can also be very gainfully used on overhead cranes for long travel and cross-travel motions where series motors are used. The automatic dynamic braking would be a very useful condition for crane safety.

In Figure 6, a circuit is presented which gives a reversing dynamic braking control with a d-c series motor and bridge-connected rectifiers. The scheme gives as simple an electrical circuit as a standard reversing plugging control with armature-shunt connection and with the same master switch operations. No spring-closed magnetic contactors are used and a positive graduated dynamic braking action is obtained up to the lowest speed. The reversals of operations are carried out in exactly the same manner as with a standard reversing plugging control.

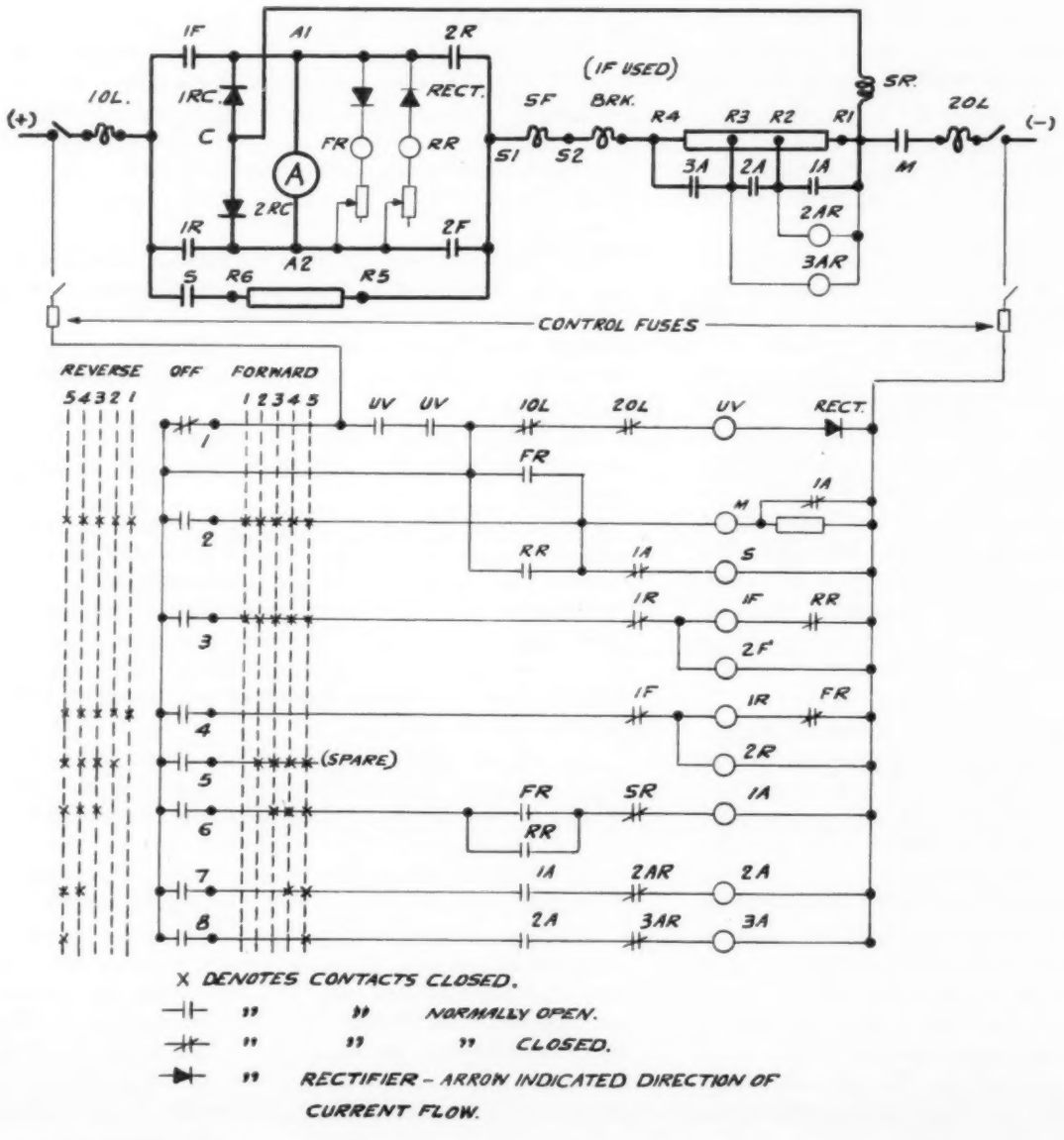



**Figure 6 — This reversing, series motor, control system, using rectifiers, does not provide dynamic braking in case of power loss.**

## OPERATION OF THE CONTROL SCHEME

*Main circuit*—The main current circuit is exactly the same as for any standard d-c steel mill motor reversing control. To obtain dynamic braking action in both directions, power rectifiers are connected in one-way bridge circuit as shown in the diagram. Rectifier 2RC permits the current to flow when the motor A1 terminal is positive, which will be the case when the motor is running in forward direction. Rectifier 1RC permits the current to flow when the terminal A2 is positive, which will be the case when the motor is running in reverse direction. The mid-point C of the rectifier bridge is connected to the main circuit resistance point R1.

When the motor is running in the forward direction, the forward directional contacts 1F-2F close and the motor operates as a standard series motor with its terminal A1 as positive and the current entering the field system at its terminal S1.

When the dynamic braking is to be applied, the master switch is moved to point-1 Reverse. If the motor armature keeps rotating in the forward direction due to the momentum of the drive and the master switch handle is reversed, the contactors M and 2R close, while the contactors 1F, 2F and 1R remain open. This would connect the motor armature and series field in a closed circuit over the rectifier 2RC. The current will flow from the motor positive terminal A1, over closed contacts 2R to S1, then through the series field to S2, through the resistances R4 to R1, then over the current relay SR to rectifier point C. From C, the current will flow over the rectifier 2RC to the motor negative terminal A2 and back into the motor armature. The current cannot flow over the rectifier 1RC as it is connected to the same positive terminal A1. The motor series field is thus connected to carry current in the correct direction for dynamic braking action to take place.

If the master switch is then moved further in the reverse direction, the contacts 1A close which shorts out the resistance step R1-R2. This reduces the resistance in the dynamic braking loop which increases the dynamic braking current. As the master switch moves to points 3, 4 and 5 in sequence, the contacts 1A, 2A and 3A close. The contacts 2A and 3A are controlled over the time-delay relays 2AR and 3AR which provide the time-delay operation for the closing of contacts 2A and 3A. The sequence thus gives controlled graduated dynamic braking until the motion is brought practically to rest.

When the motor is running in the reverse direction, the graduated dynamic braking is applied by moving the master switch to the forward direction. Under this condition, the contacts 1R, 1F and 2R remain open while the contacts 2F and M close. The dynamic braking current then flows from point A2 over the contacts 2F to the series field terminal S1, then through the field to S2, then over resistances to R1, through the relay SR to the rectifier point C. From the point C, the current passes through the rectifier 1RC to motor terminal A1 and through the motor armature back to A2. The motor series field is again excited in the correct direction for regenerative action. The graduated dynamic braking is effected in the same manner as for the forward direction by moving the master switch in the forward direction.

The series relay SR which is a current relay, controls the contactor 1A. Relay SR keeps the contacts 1A open, if the master switch is suddenly reversed to higher notches at high speeds. Dynamic braking current peaks are controlled at 200 per cent of the motor full load current at which the relay SR is set to function. Relay SR is a fluttering type of relay and its operation every time restarts the graduated dynamic braking sequence.

*Control circuit*—With the master switch in the "off" position, when the main control isolator is closed and if the line polarity is correct, the under-voltage relay UV closes and prepares the control for operation. In the first point of the master switch, the directional contactors 1F-2F or 1R-2R close depending on the direction of motion. The main line contacts M also close simultaneously with the directional contacts. The motor is then connected to the power lines over the accelerating resistances. As the master switch is moved forward, the accelerating contacts 1A, 2A and 3A close in sequence to increase the motor speed. The first accelerating step is given by the relay FR or RR, which controls the first accelerating contactor 1A. FR and RR are voltage relays and are connected across the motor armature to function as cemf relays. They are set to pull-in at about 30 per cent motor voltage. The relay FR functions as a forward direction control relay and the relay RR as a reverse direction control relay. The directional action is given by the auxiliary metallic rectifiers which are connected in the blocking direction. The control resistances in the relay coil can be adjusted to set the cemf relays for the required voltage setting in service.

The magnetic time-delay accelerating relays, 2AR and 3AR, control the accelerating contactors 2A and 3A for sequential acceleration. The number of resistance accelerating steps can be selected depending on the service requirements to obtain smooth acceleration of the system.

The control circuit generally operates in the same manner as with any standard reversing plugging controller.

*Functions of contactor S*—The contacts S in series with resistance R6-R5 give motor armature diverter circuit. The resistance R5-R6 is adjusted to give 10 to 20 per cent of the motor full load current through the series field. The contactor S closes in the first point of the master switch in either direction. This gives a definite motor excitation of about 20 per cent even if the armature is not in circuit.

The contactors M and S are also controlled over a set of normally open contacts of relays FR and RR. When any one of these relays is excited, the contactors M and S are given their retaining circuit over the closed contacts FR or RR, which retains M and S in energized position irrespective of the master switch.

When from the running position, the master switch is returned to position 1, the contactor S closes after 1A contactor has dropped out. This establishes the motor-armature diverter circuit. The motor then tends to slow down to the first point speed. If the initial running speed was 30 per cent or over, the relay FR or RR would close its contacts. If then the master switch is moved to

the "off" position, the contactors M and S remain energized over the contacts FR or RR, as the relay FR or RR has already pulled in at 30 per cent voltage. The motor armature gets disconnected from the power line, because the directional contacts would remain open when the master switch is in the "off" position. As the motor armature still keeps rotating and as the motor field is excited over the diverter circuit formed by the closing of contacts S, the voltage across the armature is maintained which retains the relay FR or RR energized and permits the coasting motion.

When the master switch is reversed for dynamic braking, the directional contacts 2F or 2R again close, while the contacts 1F or 1R remain open. This is because the contactors 1F and 1R are controlled over the cemf relay RR and FR respectively. The relay FR controls the contactor 1R, and the relay RR controls the contactor 1F. Therefore, when the master switch is reversed from the forward direction, relay FR remains closed and does not permit the contactor 1R to energize in the reverse direction as long as the contacts FR remain open. Similarly, the relay RR does not permit the contactor 1F to operate when the master switch is moved from reverse to forward direction to provide dynamic braking as long as the contacts RR remain open.

As the armature diverter contactor S remains energized in the first point along with the main line contactor M, the motor field remains established even with the armature disconnected. As soon as the dynamic braking circuit is established in any direction, the motor instantly starts regenerating to provide an instantaneous dynamic braking action, even when the motor armature speed has slowed down when the dynamic braking is applied. The dynamic braking is always positive as the field excitation remains readily established for the starting of regenerative action.

When the motion has sufficiently slowed down, the voltage relay FR or RR drops, which opens the holding control circuits for contactors M, S and 1A. If the master switch is still retained on the last point for dynamic braking, the contactor M and the proper directional contactors will again close and the motor will restart accelerating over the accelerating contactors 1A, 2A

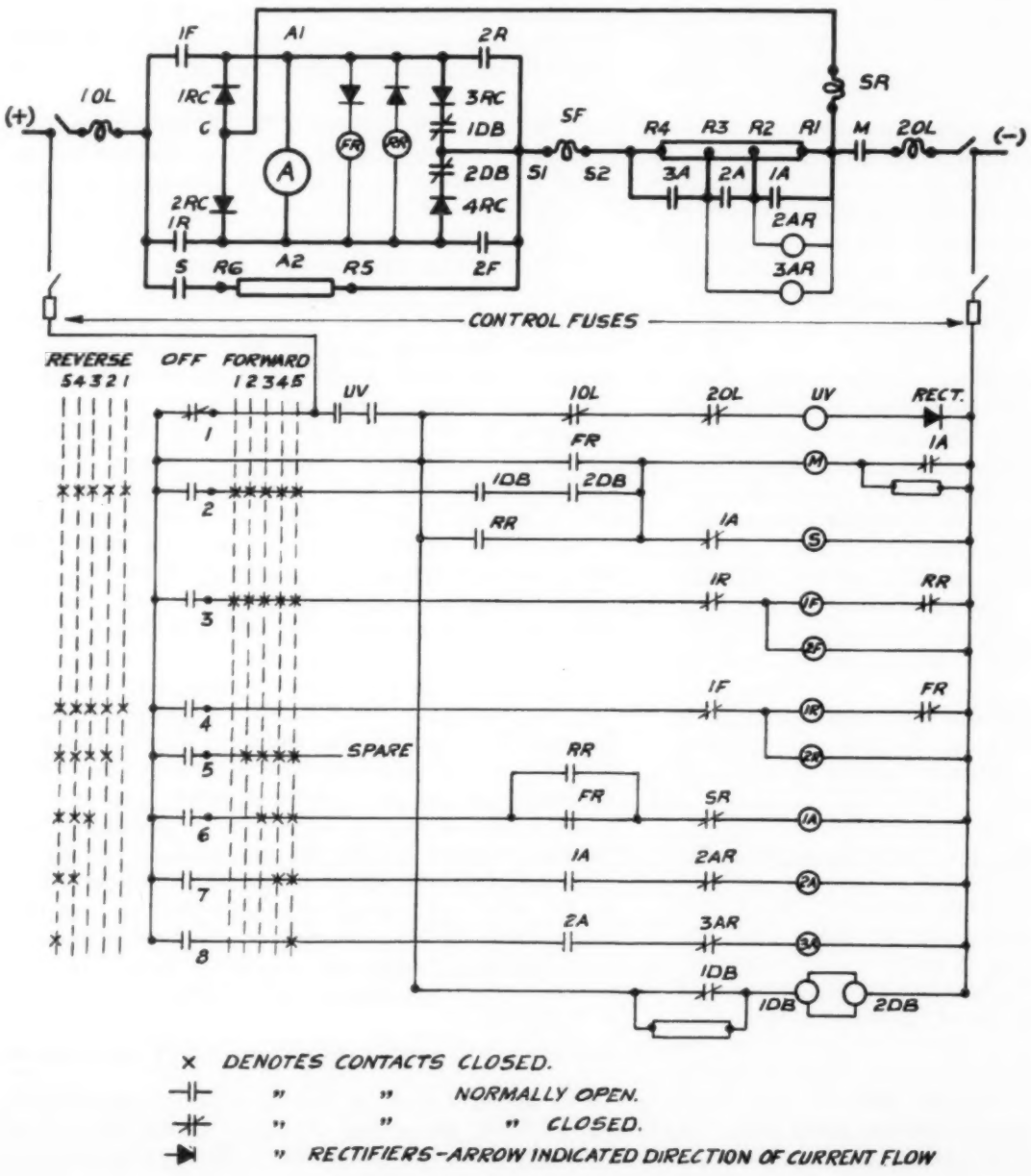



**Figure 7 — The addition of two dynamic braking contactors and two rectifiers permits fail-safe dynamic braking.**

and 3A in the normal sequence, without the necessity of bringing the master switch to neutral position.

If the operating cycles are such that the motor operates on light load for a longer period, which may cause over-speeding of the motion, the contactor S can be re-energized in the last speed point. This would give a compounding effect to the motor to hold the speed to a certain definite limit.

If an electro-mechanical brake is required, a series brake can safely be used. The brake operates only as a holding brake because the diverter contactor S gives the holding power to the brake when the master switch is returned to the "off" position from higher speed positions which are in excess of 30 per cent motor full load speed.

For speeds below 30 per cent, the controller functions as a standard plugging control to bring the motion to a dead stop. The relays FR and RR can be set to drop out at five to ten per cent of the motor voltage.

## UTILITY OF THE NEW DYNAMIC BRAKING CONTROL CIRCUIT

The new circuit functions very effectively for a reversing steel mill service for most duty cycles when a constant potential d-c control is used. The greatest advantage of the circuit lies in the fact that it permits the use of the d-c series motor with a series brake, in place of a compound motor with a shunt brake.

The cost of the new control is higher because of the use of silicon rectifiers. The cost of two 600-amp silicon rectifiers in a self-cooled enclosure would be about $500.00. If the control is installed in a well ventilated room, the cost of rectifiers will be proportionately lower, as lower size rectifiers can be used due to controlled lower ambient temperatures in a ventilated motor-room.

The elimination of the compound motor will however more than compensate for the extra cost of the rectifier, because a series motor is simpler and more robust for the rough steel mill duty. Elimination of the shunt field removes a source of trouble likely to cause expensive plant delays, while the control circuit becomes simple because no shunt field failure protection or field economy relays and shunt field cables are required. The problem of faulty field connection in case of a compound motor is also eliminated, which saves time considerably when a motor has to be changed in service.

The modern robust silicon rectifiers would give trouble-free service with long life and give positive contactless operation for dynamic braking action of the motor.

## STEEL MILL EOT CRANE SERVICE

For the electrical overhead traveling cranes, the d-c series motor is the only motor normally used. The control circuit shown in Figure 6 can therefore be used very conveniently for the crane long travel and cross-travel motions. The use of the series brake which is used only as a parking or power failure brake, would eliminate the use of d-c shunt brakes or the hydraulic brake. As the series brakes are used for the crane hoist service, this will give a common series brake for both long travel and hoist services and would reduce problems of maintenance and spares to a very great extent.

It will however be observed that the circuit in Figure 6 does not provide dynamic braking action in the "off" position of the master switch or in case of power failure. The series brake therefore becomes desirable for emergency stopping if the power fails while the crane is running at a high speed.

## POWER FAILURE DYNAMIC BRAKING CONTROL

It would indeed be a great advantage if the series brake is removed from the crane travel service and provide a control scheme which would give dynamic braking action every time the motor is switched off from the power lines.

Figure 7 gives such a control scheme which provides automatic dynamic braking in case of power failure and also gives graduated dynamic braking for normal reversing service. The control is similar as in Figure 6 except that two more power rectifiers with two spring-closed contactors are added to provide off-point dynamic braking circuit. When the power fails, the spring-closed contacts 1DB and 2DB close and connect the rectifiers 3RC and 4RC in the motor circuit. The dynamic braking circuit will then be as shown in Figure 4, which gives dynamic braking action in both directions.

In case of power failure, full resistance will always be in the circuit. The initiation of the dynamic braking action will therefore depend on the speed of the motion at the time power fails. If it is considered essential that the crane must be brought rapidly to a slow speed, an additional spring-closed contactor can be added with its coil in parallel circuit with contactors 1DB and 2DB. This contactor 3DB will bridge a certain step of the resistance R1-R5 to give full load braking torque at about half the speed. At high speed therefore, the braking will be rather strong, but this could be permitted in view of the fact that it will be carried out only in an emergency when power fails. The dynamic braking contactors are electrically interlocked with the main line contactor M, so that M cannot close unless the spring-closed contactors are energized and their main current contacts open positively. This is essential to prevent armature getting shorted over the rectifiers 3RC or 4RC if contacts 3DB or 4DB remain closed in service.

The addition of two more rectifiers 3RC and 4RC and the two spring-closed contactors naturally add to the cost of the control. The additional cost of two more rectifiers will be about $500.00. However, the electro-mechanical brake or hydraulic brake is then eliminated. The saving in the cost of the brake will therefore compensate for the additional cost of all the four rectifiers and extra contactors. Elimination of brakes is a very great advantage as the constant maintenance and adjustment of the brakes are also simultaneously eliminated, which will indeed be very welcome to all crane maintenance men.

## DYNAMIC BRAKING CIRCUIT WITHOUT RECTIFIERS

For services where additional costs of rectifiers are not justified, the circuit in Figure 6 can also be set up without the rectifiers, by replacing the rectifiers

1RC and 2RC by two normal magnetic contactors. These contactors are properly controlled over the master switch to give proper connections for the dynamic braking circuit in either direction. Figure 8 gives the complete control where the contacts DBF and DBR replace the rectifiers 2RC and 1RC repectively. The contactor DBF, called dynamic braking forward contactor, is so connected that it closes when master switch is reversed to give dynamic braking to the forward motion. Similarly, the contactor DBR, called dynamic braking reverse contactor, is connected so that it closes in the forward position of the master switch to give dynamic braking to the reverse motion. In all other respects, the circuit is exactly the same as in Figure 6.

The new control scheme can thus be designed with or without the power rectifiers. With or without the series brake, therefore, the circuit in Figure 8 can be very effectively applied for crane long travel motion. If the brake is introduced, then it is better to provide rectifiers, as the cost of the brake and the rectifiers will almost be same for most d-c 600 series motor sizes.

### ADJUSTMENT OF RESISTANCES

The circuit is designed for three steps acceleration. The full resistance R1–R4 will give a starting current of about 100 per cent full load current. The diverter resistance R5–R6 is selected such that when the motor armature is disconnected, the current through the series field with R1–R4 resistance would be about 20 per cent. This would give a starting torque of about 100 per cent full load torque. If it is desired that for certain overhead crane applications, the starting torque has to be reduced, an additional resistance step with a contactor can be inserted as the first accelerating step. Master switch contact 5 is kept free for that purpose.

The next acceleration step will be at about 30 per cent of full load speed when R1-R2 step is shorted out. Maximum accelerating current at this step should not exceed 200 per cent. The third and fourth steps are taken over time-delay accelerating relays which are so adjusted that the accelerating current peak at each step does not exceed 150 per cent.

When the dynamic braking action takes place, the worst condition will be when the master switch is reversed at the maximum speed. When the drive is over-motored, the light load speed with series motor may reach 250 per cent of the normal if the light load period remains for a longer time.

In order to keep the maximum dynamic braking current peak approximately to within 200 per cent of

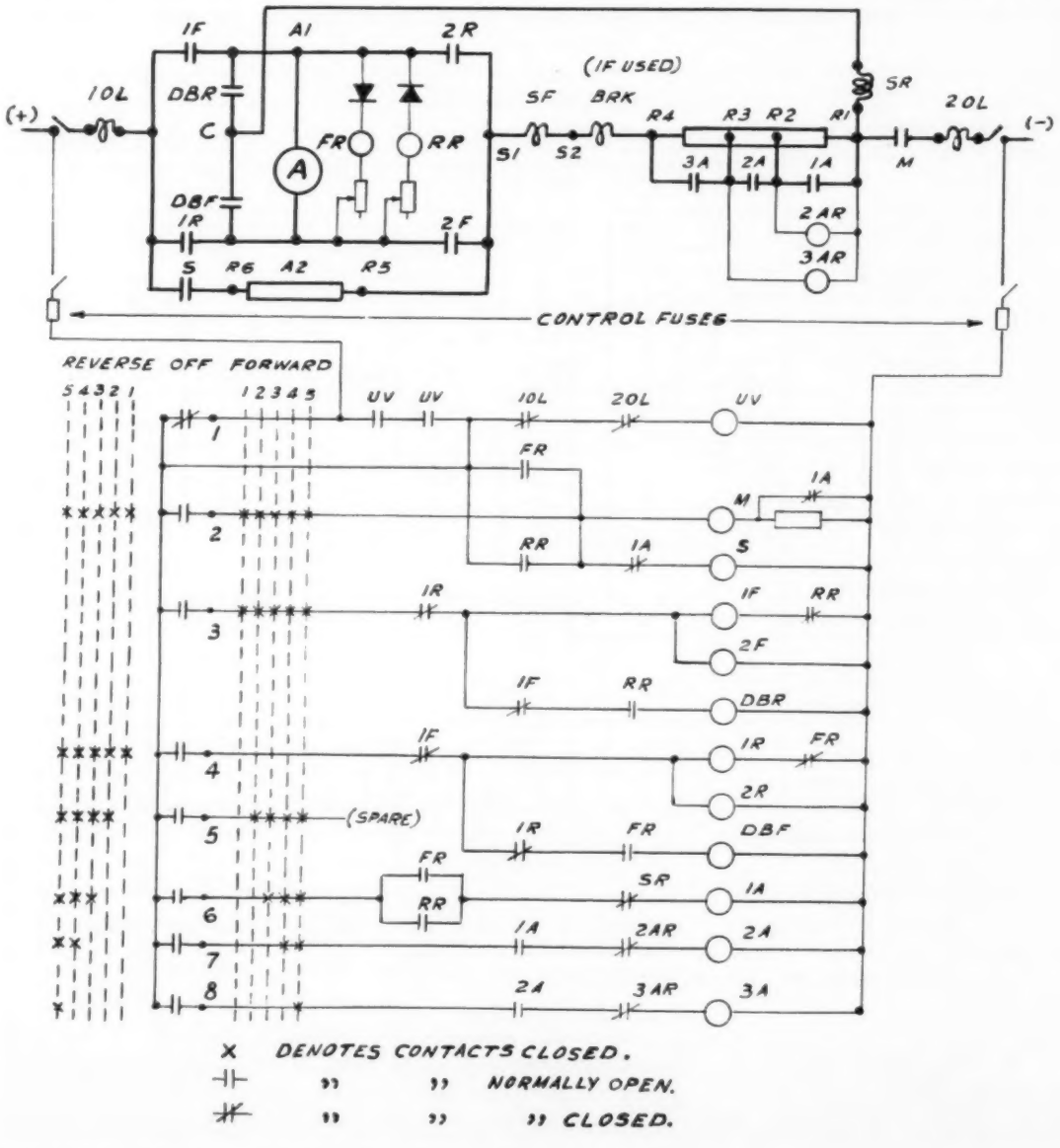



**Figure 8 — Rectifiers can be replaced by contactors (DBR and DBF) when the expense of rectifiers cannot be justified.**

full load current, the total resistance in the dynamic braking circuit should be at least 1.25 per unit. As the series motor field starts saturating at currents higher than full load, the motor field strength does not increase proportionately to the field current. For AISE 600 series d-c motors, the field strength at 200 per cent current will be about 115 per cent. The maximum dynamic braking torque would therefore be about 230 per cent of the motor full load torque.

It will therefore be observed that the accelerating resistance steps match approximately with the dynamic braking requirements of the motor selected. The dynamic braking current relay SR would permit the current peak value to 200 per cent if the master switch is moved too fast during the decelerating sequence.

The resistances are therefore designed to limit the maximum current peaks to within 200 per cent of the full load current requirements of the drive. As the AISE 600 series motors can safely commutate 300 per cent of the normal rated current, the control would permit safe operation of the motor with smooth acceleration and controlled braking.

Figure 9 gives a table indicating the sequence of contacts closing, relays setting and resistance steps for Figures 6, 7 and 8.

## SAFETY INTERLOCKING PROTECTION

Electrical polarity of the incoming power lines with rectifier control should be maintained as per the diagram, as otherwise dynamic braking action will fail or short circuit would occur over the rectifier 1RC or 2RC. To prevent this, the coil of UV is connected in series with a directional control rectifier. This will prevent UV from getting energized to give holding power to the main contactors when the master switch is moved from its neutral position, in case the polarity of the main power line is not correct.

The directional contactors 1F-2R and 1R-2F are mechanically interlocked so that only one can close or remain closed at a time. As a further safeguard, 1F-2F and 1R-2R are also electrically interlocked, respectively over 1R and 1F auxiliary contacts.

The coil of contactor M is given an economy holding resistance in series. This resistance is shorted over normally closed auxiliary contacts 1A. This permits M to close only when 1A is open. This gives a useful interlocking between M and 1A. The contacts 1A operate on high accelerating and dynamic braking currents. If copper contacts are used, it is likely that the contacts may freeze in service if not properly maintained. If contacts 1A freeze at any time, resistance step R1-R2

**Figure 9 — The contactor sequence, relay settings and resistance steps for the three dynamic braking circuits discussed are indicated.**

| CIRCUIT FIG. NO. | DEVICES CONTACTORS | FUNCTIONS | REVERSING OPERATIONS (X - DENOTES CONTACTS CLOSED) | | | | | | | | | | | DYNAMIC BRAKING (X-DENOTES CONTACTS CLOSED) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | FORWARD | | | | | OFF | REVERSE | | | | | FORWARD | | | | | OFF | REVERSE | | | | |
| | | | 5 | 4 | 3 | 2 | 1 | | 1 | 2 | 3 | 4 | 5 | 5 | 4 | 3 | 2 | 1 | | 1 | 2 | 3 | 4 | 5 |
| 6 7 8 | M | MAIN LINE | X | X | X | X | X | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| " | 1F | FORWARD DIRECTION | X | X | X | X | X | | | | | | | | | | | | | | | | | |
| | 2F | | X | X | X | X | X | | | | | | | | | | | | | X | X | X | X | X |
| " | 1R | REVERSE DIRECTION | | | | | | | X | X | X | X | X | | | | | | | | | | | |
| | 2R | | | | | | | | X | X | X | X | X | X | X | X | X | X | | | | | | |
| " | 1A | 1st ACCELERATING OR BRAKING | X | X | X | | | | | | X | X | X | X | X | X | | | | | | X | X | X |
| " | 2A | 2nd ACCELERATING OR BRAKING | X | X | | | | | | | | X | X | X | X | | | | | | | | X | X |
| " | 3A | 3rd ACCELERATING OR BRAKING | X | | | | | | | | | | X | X | | | | | | | | | | X |
| " | S | ARMATURE DIVERTER | | | | X | X | | X | X | | | | | | | X | X | X | X | X | | | |
| 7 | 1DB | OFF POINT DYNAMIC BRAKING SPRING CLOSED | | | | | | X | | | | | | X | X | X | X | X | X | X | X | X | X | X |
| 7 | 2DB | | | | | | | X | | | | | | X | X | X | X | X | X | X | X | X | X | X |
| 8 | DBF | DIRECTIONAL DYNAMIC BRAKING | | | | | | | | | | | | X | X | X | X | X | | | | | | |
| 8 | DBR | | | | | | | | | | | | | | | | | | | X | X | X | X | X |
| 6 7 8 | FR | FORWARD VOLTAGE RELAY | 30% VOLTS TO PULL | | | | | | | | | | | | | | | | | | | | | |
| | RR | REVERSE " " | 5 % VOLTS TO DROP | | | | | | | | | | | | | | | | | | | | | |
| " | UV | UNDER VOLTAGE RELAY | 55% VOLTS TO PULL | | | | | | | | | | | | | | | | | | | | | |
| " | 2AR | TIME DELAY RELAYS | 1·00 SEC. TO DROP | | | | | | | | | | | | | | | | | | | | | |
| " | 3AR | | 0·60 SEC. TO DROP | | | | | | | | | | | | | | | | | | | | | |
| | SR | CURRENT RELAY | 200% CURRENT TO OPERATE | | | | | | | | | | | | | | | | | | | | | |
| | 10L 20L | CURRENT RELAY | 250% " " " | | | | | | | | | | | | | | | | | | | | | |

RESISTANCES

R1-R2 - 0·4 E/I OHMS
R2-R3 - 0·45 " "
R3-R4 - 0·25 " "
R5-R6 - 4·00 " "
E/I - 0·12 OHMS (AVERAGE)

will remain shorted. Under such a condition, contactor M will not reclose, once the master switch is brought to neutral position at motor standstill. This will prevent continued operation with 1A contacts permanently frozen which would give higher current kicks all the time.

The overload relays 10L and 20L are set to operate instantly at 250 per cent of motor rated current and de-energize the control by opening UV relay.

In case of the circuit in Figure 7, the main line contactor M is interlocked over 1DB and 2DB auxiliary contacts, so that M can close only when 1DB and 2DB contactors are first energized and open their main contacts. Similarly, in case either 1DB or 2DB drops out in service, contactor M would open and disconnect the motor from the line.

In case of the circuit in Figure 8, the contactors 1F-DBR and 1R-DBF are to be mechanically interlocked so that only one contactor of the pair can close or remain closed simultaneously. The mechanical interlocking in Figure 8 will therefore be DBR-1F-2R and DBF-1R-2F such that 1F interlocks with both DBR and 2R, and 1R interlocks with both DBF and 2F.

## DUPLEX MOTOR CONTROL

For two motor operations, the best known circuit is the dynamic braking scheme of control, in which the motors and fields are cross-connected over spring-closed contactors. The connections are so made that the armature of one motor gets cross-connected to the series field of the second motor. Each motor and field closed-loop has a dynamic braking resistance to limit the dynamic braking current. One motor is provided with armature reversal control and the other motor has field reversal control. This arrangement gives dynamic braking connections over four spring-closed contactors, two for each circuit. This scheme is used only as a power failure dynamic braking circuit, which is superimposed on the standard reversing plugging control.

With the circuits given in Figures 6, 7 and 8, the two motors dynamic braking can be easily obtained in the normal manner, similar to the standard arrangements for the duplex controllers. The best synchronized operations of the two motors will be obtained with double-pole contactors, one pole for each motor and using separate sets of relays for each motor with their contacts in series to control the double-pole contactors.

## SUMMARY

The scheme of control shown in Figures 6, 7 and 8 gives a completely new circuit for the constant potential d-c reversing steel mill drives.

It is true that the industry has so far almost standardized on the reversing, plugging control schemes for mill auxiliary services and the control has served the industry well. Braking by means of plugging is in fact braking a motion through a worm gear which depends on the reverse efficiency of the gear which is less than the forward efficiency. The braking effort therefore required is more than the linear driving effort. Braking through the gear therefore does affect gear life. The braking over the driving motor itself by means of dynamic braking action gives a much smoother action to bring the motion to a slow creeping speed. Table I gives the worm gear efficiencies for comparison.

**TABLE 1**
**Worm Gear Efficiencies**

| Speed, fpm | | Forward eff. per cent | Reverse eff. per cent |
|---|---|---|---|
| Per unit | Travel | | |
| Full | 325 | 0.87 | 0.85 |
| 0.25 | 81 | 0.79 | 0.74 |
| 0.05 | 16 | 0.70 | 0.59 |
| Stopped | ... | 0.52 | 0.51 |

From the viewpoint of gear efficiency in actual operations, however, the disadvantages of plugging condition cannot be considered too serious. Viewed electrically however, the new dynamic braking reversing scheme discussed in this paper is much more advantageous, as it permits the use of a standard mill type d-c series motor for practically all steel mill reversing services. A d-c mill type series motor is definitely considered the most robust and the simplest, compared to similar shunt or compound motors. Its general use would therefore add to the continuity of plant operations and maintenance to a great extent.

The circuit also permits the use of the more robust AISE frame series brake, which again is made to function only as a holding brake or a power failure brake. A series brake does not need any special control and economy resistances, and operates much more snappily when energized or de-energized.

In fact, the new dynamic braking circuit with or without rectifiers, providing proper design of resistance steps, would eliminate the necessity for a mechanical brake as the motion can be brought to almost a standstill by graduated dynamic braking only. The brake would be added only where the motion, due to safety reasons, must be held to a dead-stop when the motor is switched off.

It is true that the general adoption of the new dynamic braking circuit with rectifiers, depends on the availability of good reliable robust rectifiers which can be installed in all reasonable locations.

The development of modern silicon power rectifiers has now put on the market a very robust semi-conductor rectifier which can be used up to 50 C ambient and which is insensitive to moisture and dust.

In a paper "Standardization of d-c Crane Controls for Steel Plants," which is published in the 1958 Proceedings AISE the author has put forth preliminary suggestions for standardizing the electric circuits for steel mill cranes. The present paper would meet with the several criticisms on the long travel dynamic braking control scheme suggested in the previous paper.

# Discussion

PRESENTED BY

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**K. S. KUKA, Superintendent, Electrical Engineering & Construction, M. N. Dastur & Co., Private Ltd., Consulting Engineers, Calcutta, India**

**S. Rifkin:** The circuits proposed in Figures 6, 7 and 8 of Mr. Kuka's paper provide an arrangement that answers some of the problems mentioned in the

discussion of his December, 1958, proposed standard crane traverse circuit. The basic principles are quite sound. Rectifiers that were selected with due consideration to maximum transient conditions have been used to provide emergency dynamic braking of traverse drives. In order to assure that motor field flux was available to generate dynamic braking current, if power failed while coasting, a teaser field contactor (TF) has been connected in a manner similar to the S contactor of Mr. Kuka's circuits.

On traverse drives requiring collectors between the drive and the control panel, series brakes have been utilized to avoid the additional collectors that shunt brakes would require. When "off" position coasting was required for such installations, the TF contactor has been used to keep the series brake energized, either for a definite time or until the speed had decreased to a predetermined value.

There may be some debate as to whether or not normal stopping by dynamic braking is more desirable than plugging. As an aid to making such a comparison the per cent speed-per cent torque curves (Figure 10) have been prepared for an MD-608, 230-v motor, using the resistance values and contactor sequence indicated by Mr. Kuka in Figure 9. Neglecting the power circuit time constant,the performance obtained when the master switch is moved from one direction to full speed in the opposite direction would be as follows:

1. If the motor is running above 236 per cent speed, dynamic braking Curve I will be established and SR will pick up since point A represents 200 per cent armature current (540-v cemf). The drop-out setting of SR has not been indicated, but point B corresponds to 50 per cent current; so it is conceivable that the 1A contactor would pick up to establish Curve II at a speed on the order of that represented by point B. After time-delay relay 2AR allows contactor 2A to establish Curve III, relay 3AR timed operation allows 3A to establish Curve IV. At point K, the armature voltage would correspond to the 5 per cent setting of FR and RR; therefore, all accelerating contactors would drop out, and the first point in the reverse direction (Curve 1R) would be established.

2. If the speed is between 175 and 236 per cent when the master switch is reversed, contactor 1A will establish Curve II with an armature current in excess of the 200 per cent represented by point D; therefore, relay SR will drop out 1A, and the sequence will be as described under 1 above.

3. At any value of speed, if relay 2AR does not maintain Curve II connections long enough to reduce the speed to less than 86 per cent before 2A picks up, Curve III will be established with an armature current in excess of the 200 per cent represented by point G. Relay SR will drop out the accelerating contactors and the sequence will be as described under 1 above.

4. If 3AR does not maintain Curve III long enough to bring the speed below 36 per cent the operation of SR when 3A picks up will be the same as in 2 and 3 above.

For many traverse drives, torque peaks on the order of 245 per cent (corresponding to points A, D, G and J) may result in wheel slippage. It is also possible that poor commutation may be encountered if Curve II is established above 175 per cent speed, since point D

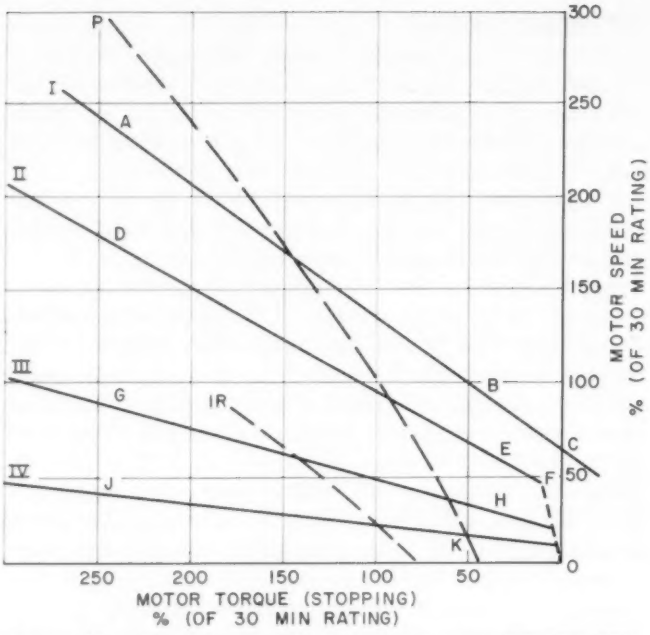



**Figure 10 — The torque-speed curves, for an MD-608, 230-v motor, indicate the dynamic braking from various speed ranges.**

corresponds to 200 per cent current at a motor cemf of 407 v.

As an example of conventional plugging performance, Curve P applies with a total line resistance of 1.8 per unit ohms. If a higher plugging torque is permissible for a particular installation, it is a simple matter to reduce the plugging resistance; thereby moving curve P to the left. For a particular torque-limit condition, it is quite likely that a plugging circuit will permit stopping just as rapidly as a graduated dynamic braking circuit and will involve fewer contactor operations. If an additional plugging step is desired, either an additional plugging relay can allow the first step of resistance to be short-circuited at approximately 80 per cent speed, or an additional plugging contactor can be provided. (The latter recommendation was made by D. C. McCrady, page 495 of the 1954 Proceedings AISE.)

Although standard reversing-plugging control seems to be considered adequate for the majority of traverse drives, most control manufacturers can readily provide many special features, when they are specified by the crane purchaser. Some of the special features are as follows:

1. A permanent armature shunt resistor to limit the maximum no-load speed to a specified value.
2. An armature shunt connection on the first one or two speed points to provide slow-speed control with a light load.
3. An extra plugging relay to provide an additional plugging step without increasing total number of contactors.
4. Two plugging steps, including an additional contactor and relay.
5. Emergency dynamic braking.
6. Service dynamic braking, with one, two, or three steps, as specified.
7. A teaser field connection to maintain motor field flux when coasting. If a series brake is used, this connection will also keep the series brake energized.

**K. S. Kuka:** It may be stated that the resistance values and the 200 per cent current setting of the SR relay given in Figure 9 of the paper were estimated for a reversing mill auxiliary service, where the free running speed was not expected to go beyond 200 per cent for the normal repetitive service cycles.

For a crane long travel motion, it is possible for the free running speed of the motor to exceed 200 per cent, and where long distance travel is required, such speeds may reach 240 per cent depending on the motor size and the gear ratio selected for the drive.

With crane long travels, the problem of wheel slippage on sudden braking has to be considered, and the braking torque has to be controlled to prevent wheel slippage under normal service.

For a crane long travel service, the resistance step R1-R2 has to be selected higher so as to give a total starting torque about 50 to 60 per cent. Such a torque would enable the motor to overcome static friction to permit the crane to accelerate smoothly at a slow rate.

With the motor frame 608 of the example, the total internal resistance of the motor and the external wires can be assumed to be 0.2 per unit, taking the normal E/I of the motor as one per unit resistance.

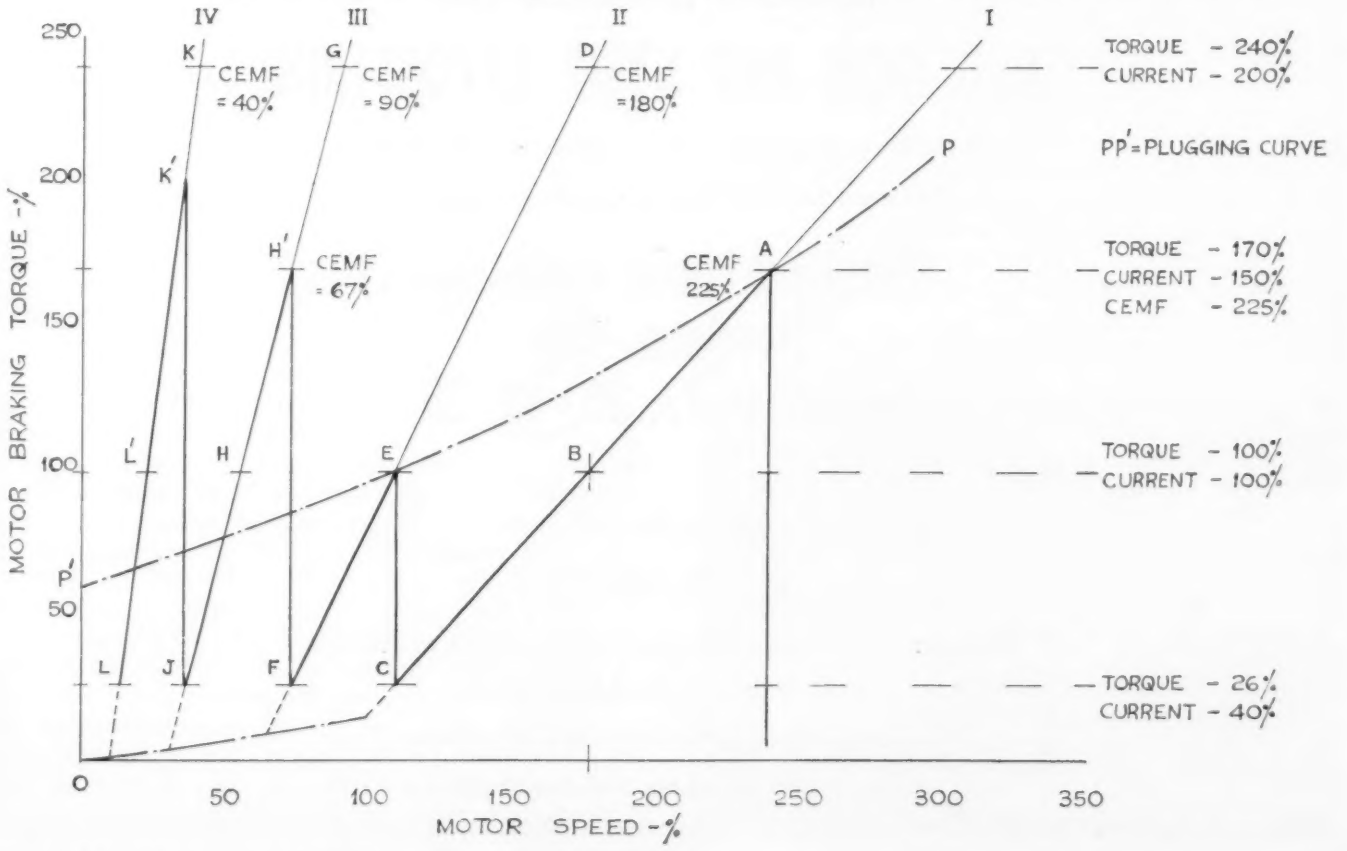
The total circuit resistance to provide 60 per cent starting torque would therefore be about 1.5 per unit. This would require about 1.3 per unit ohm external resistance in the circuit. The resistance step R1-R2 will therefore be 0.6 per unit instead of 0.4 as given in Figure 9.

Referring to Curve 2 of Mr. Rifkin's comments, it will be observed that when contacts 1A close with the initial dynamic braking speed at 175 per cent, the motor develops a torque of about 240 per cent with the current at about 200 per cent and the motor emf at a momentary value of 407 v. With the SR relay setting at 200 per cent, the transient current and voltage will be higher if 1A contacts close at speeds over 175 per cent as is clearly pointed out by Mr. Rifkin. This is definitely not desirable from viewpoint of commutator sparking and maintenance of the motor, with ½-hr crane service rating.

For smoother braking of the crane long travel motion, therefore, the SR relay setting will have to be lower than 200 per cent. The preferable current setting for the relay SR will depend on the type of crane service and the free running speed of the crane bridge.

To explain the problem in a better way, the curves are drawn in Figure 11, which indicate the speed-torque variations during dynamic braking sequence for a 608 frame AISE mill type d-c motor. Curve I is for 1.5 per unit ohm total resistance, while Curves II, III and IV are for 0.9, 0.45 and 0.2 per unit ohm. 0.2 per unit ohm is taken as the minimum resistance of the 608 motor and the wires. The relay SR is set to pull at 100 per cent full load current and drop out at 40 per cent current. The Curve I shows that when the motor is reversed at 240 per cent speed, the maximum braking current is 150 per cent, giving a peak torque of 170 per cent, shown at point A. Under this condition, therefore, as soon as the master switch is reversed, dynamic braking circuit is established and the relay SR pulls in. The motor then operates on the Curve I until the speed drops to point C which is about 100 per cent normal speed. At point C, the relay SR drops. The dynamic braking sequence then follows along points C, E, F, H′, K′ and L, providing rapid braking action to bring the motion to a quick stop. The sequence

**Figure 11 — The torque-speed curves for an MD-608 motor show variations in relation to the unit resistance.**



is shown by thick lines in Figure 11.

If the reversal is made at 175 per cent initial speed with closing of 1A, the momentary transient torque reaches about 240 per cent with transient current peak of 200 per cent. The relay SR instantly pulls in and brings the operation back to Curve I. At point D on Curve II, the transient peak values of current is 200 per cent and voltage is 180 per cent, with a transient torque of 240 per cent at the motor shaft. These transient values are well within the capabilities of a 600 series, d-c, AISE standard motor. Thus between 100 to 240 per cent speeds, the motor operation under dynamic braking would become effective and rapid in action. The duration of the transient high torque is so short that no effect will be felt on the crane.

If the reversal is made when the speed is just below 100 per cent on closing of 1A contacts, the motor operates on Curve II which lasts for about one second, the timing of relay 2AR. During this period, dynamic braking torque gradually decreases from 80 per cent motor torque to 40 per cent. Within one second time interval, if the braking happens to reduce the speed only to point F, the torque-speed will be transferred to Curve II, with a peak braking torque of about 160 per cent at point H′. At point F, the motor cemf is about 67 per cent and when the contacts 1A close, the transient current peak at point H′ reaches about 150 per cent. At this point SR relay operates and brings the motor back to Curve II and the sequence repeats itself. If the 1A contactor is allowed to hold in once 2A closes, the operation of SR relay at point H′ permits the braking action to take place along Curve III, which then is transferred to Curve IV, if the speed still did not go down to within 5 per cent. At point, J, 3A contacts close and the motor shifts to Curve IV point K′ when a transient torque of 200 per cent is applied which will then reduce rapidly to point L when the relay FR or RR will drop out to permit the motor to reverse.

Under actual conditions, the magnitude of the dynamic braking torque will be such that the motion will stop before the relay 3AR has timed out to close the contacts 3A. The effects would be to provide rapid graduated dynamic braking to the crane motion on all speeds from 240 per cent of normal full load speed of the motor. The momentary maximum transient torque likely to be imposed would be about 240 per cent with about 180 per cent motor cemf. The effective maximum braking conditions imposed on the equipment thus is about the same as with the plugging control scheme if the starting torque is set at about 60 per cent which is the normal required to permit a crane to start moving on the first point of the master switch. The plugging speed-torque condition for a 608 motor with 60 per cent starting torque and 150 per cent current limit is shown on Curve P′P in Figure 10.

The advantages of the control scheme can be judged only when it is tried out in practice and its operation compared with the standard plugging method of control. The main advantage is that the proposed circuit permits the use of the d-c series motor where graduated dynamic braking action is intrinsic in the circuit, and where the use of compound motors and shunt brakes could be eliminated for most steel plant reversing services. It will be a great maintenance advantage to the electrical operators, if only the series motors and series brakes are used for all mill constant potential reversing d-c drives. ▲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# A New Application for Salt Bath Treatment of Eutectoid Steel

by E. W. STOTZ, Assistant Chief Metallurgist, Bethlehem Steel Co., Johnstown, Pa.

*. . . . heat treating practices can be changed in order to get labor, space and equipment economies, at the same time to improve the final product . . . .*

"NECESSITY is the mother of invention," according to an old adage. The heat treating process to be described probably cannot be classed as an invention, but is considered unique. If there were no problems with the existing heat treating process we would never have considered a change. As it worked out, it was possible to change heat treating equipment on three units for about the cost of one proposed unit, to save space in an over-crowded area and to make a better product.

The product to be heat treated is made from steel of the eutectoid composition and is processed through our primary mills as a 2½-in. billet. These billets are rolled into a modified "T" section approximately two in. in height, and then sheared to the blank length of about one ft. The blanks are heated to 1850 F in a gas-fired furnace and then formed in two stages on a press. The product is then heat treated to the desired hardness range. Figure 1 shows the product and how it is used. It is essentially a spring and its purpose is to prevent forward or reverse movement of the rail. It is driven on the rail with a hammer, as shown. The important characteristics necessary are good impact resistance or toughness and good spring-back, or resistance to deformation, since it must fit tightly on the rail and, in many cases, the parts are knocked off one rail and redriven on another.

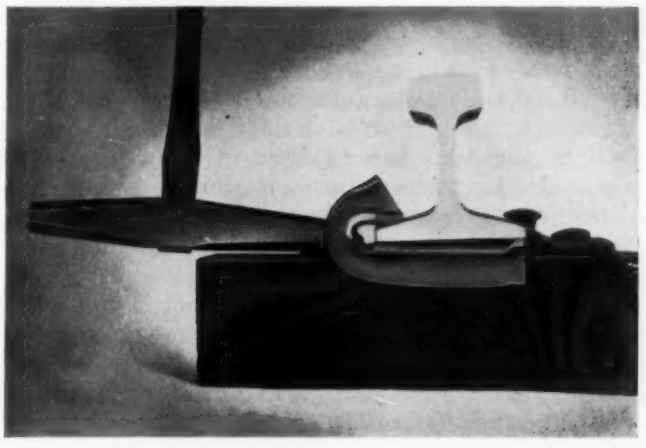
Before describing the present process, a description of the old process and its disadvantages is necessary. The formed parts dropped from the press at a temperature of about 1700 F into an oil-quench tank with jet type agitation, maintained at about 200 F. The parts were conveyed out of this tank to either gas-fired or electrically-heated furnaces and tempered to the desired hardness range. Tempering temperatures ranged from 950 to 1100 F. The microstructure produced by this treatment was tempered martensite. The two main disadvantages of this system were:

1. The parts moved through the tempering furnace at a steady rate only when it was being continuously charged, because the parts were placed on pallets moved by a pusher system. Any delays caused by either breakdowns or spells by the crew resulted in excessive tempering and produced parts with hardness below the specified range. In many cases the operator's judgment was used to decide whether the parts in the furnace were satisfactory or should be scrapped.

2. The temperature at which the parts entered the oil quench was quite critical. Normally it was 1700 F. In case of delays, however, the piece cooled off and did not quench properly.

These two features necessitated a great deal of

**Figure 1 — Installation of the rail anchor is done with a sharp blow of the hammer.**



inspection and testing to insure quality and did not produce a consistently good product.

Accordingly, it was decided to improve the heat treating facilities by replacing the existing tempering furnaces with salt-bath furnaces with automatic drive so that all pieces would be conveyed through the furnaces without any stops, thus eliminating the main variable in the old process. The cycle was planned for a 20-min temper at about 1050 F. When this proposal was sent out for bids several equipment manufacturers voiced doubts about the safety of the operation as planned, due to the danger of possible violent reactions when the oil-quenched part was immersed in liquid salt at 1050 F. Because of this feature the entire project was restudied and out of this restudy came the present procedure.

Several things were proposed, including an elaborate cleaning and drying system ahead of the salt furnace, quenching in one salt furnace and tempering in a second one. While trying to select the best method and upon studying the "S" or time-temperature transformation curves for this grade of steel, it was indicated that the oil quench could be eliminated entirely, using only one salt-bath furnace and quenching directly from the forming press into molten salt at 1050 F. This was tried experimentally in a small salt-bath furnace in the metallographic laboratory, but the heat-treated parts were too soft because, due to too slow a cooling rate, the nose of the "S" curve was reached too late. Theoretically, to isothermally anneal (as shown on Figure 2), which is the type of heat treatment we were attempting, the part had to cool from 1700 to 1050 F in ¾ sec. The microstructure obtained was a mixture of coarse pearlite which forms above the nose of the curve and the material was not hard enough because of this. What was wanted was fine pearlite which forms at the nose of the curve and is considerably harder. Just for the sake of completeness we quenched the parts in molten salt at various temperatures between 1050 and 500 F to see what would be obtained. We obtained the desired hardness on parts quenched between 600 and 650 F. Temperatures above that resulted in low hardness while temperatures below 600 F resulted in extremely hard parts above the desired range. The parts which met the required hardness range were examined under the microscope and were found to contain the fine-grained pearlite we had been looking for at 1050 F. This structure was a mixture of various types of fine pearlite. No trace of bainite, which forms at quenching temperatures under 900 F, could be detected microscopically. The several parts which met the desired hardness range were given our standard tests driving them on and off rails a number of times at our local testing station. They seemed to have the right combination of ductility and toughness required in this product and passed testing without breaking during driving and without being loose on the rail after being driven. As a matter of fact we drove them quite a few times and could not break them.

Referring again to Figure 2, theoretically what happened in the heat-treating procedure must be as follows: The process is somewhere between isothermal annealing and austempering but cannot be considered either. In order to anneal isothermally, the steel must be quenched from 1700 F (in our case) to 1050 F in ¾ sec. Then it need only be held at that temperature for about 5 sec to complete the transformation of austenite into fine pearlite. To anneal isothermally it is not necessary to do so at the nose of the curve. In some cases coarse pearlite might be a desirable structure which would call for a higher annealing temperature. On the other hand, austempering, also depicted on Figure 2, uses salt bath temperatures similar to those contemplated by us, but to austemper it is necessary to get a fast enough cooling rate to pass the nose of the "S" curve in less than ¾ sec and then hold the part in molten salt until the austenite is all transformed. At temperatures between 600 and 650 F this would take about 10 min. This treatment would produce lower bainite as a structure. This is fairly ductile but considerably harder than called for by the requirements.

Essentially the heat treatment used is shown by the other line on Figure 2. The cooling rate in molten salt, when quenched to 1050 F, was not fast enough to reach the nose of the "S" curve, but when the salt was at 600 to 650 F the cooling rate was such that it hit the nose of the curve and complete transformation into fine pearlite took place before the part reached 900 F where upper bainite begins to form. Thus, since no upper bainite could be detected microscopically, transformation was complete in 10 to 20 sec. Figures 3 and 4 shows structures of this new practice versus the old practice of oil quenching and tempering, at 100 magnification. Because this treatment is different from regularly accepted heat-treating procedures a number of parts were quenched in molten salt at 625 F and tested at great length to see if this process was metallurgically sound. The material passed all tests with flying colors.

All of the tests so far had been carried out in the small laboratory salt bath furnace. One of the suppliers

**Figure 2 — The time-temperature transformation curve indicates the quench time for various final structures.**

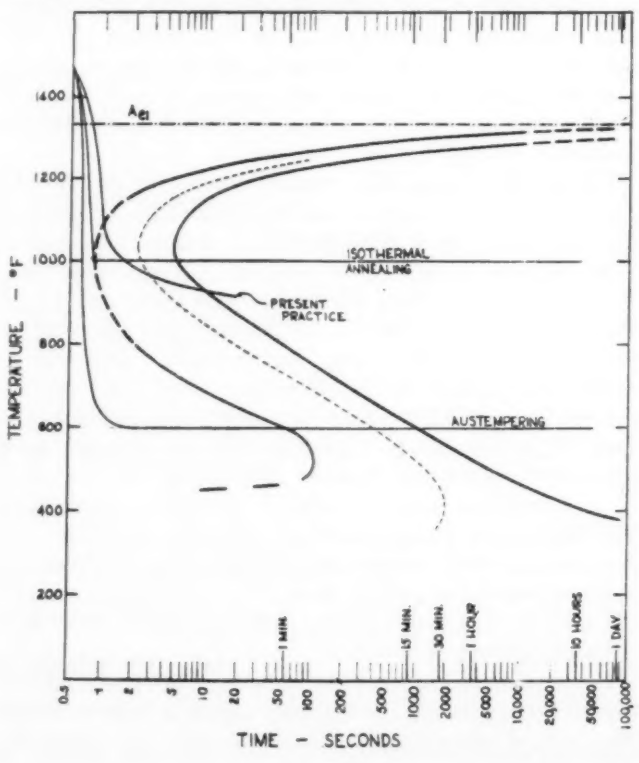


**Figure 3 — A martensitic grain formation resulted from previous practice (100X).**

**Figure 4 — A pearlitic grain formation was obtained using salt bath furnace (100X).**

of salt bath furnaces offered the facilities at their research laboratory for more extensive testing. The salt furnaces in this laboratory were of a size similar to those which would be used if it were decided to adopt this type of treatment on a production basis.

A series of tests were run with salt temperatures varying from 500 to 800 F and the results confirmed previous experimental work. Salt temperatures under 600 F provided a fast enough cooling rate to form some bainite before transformation was complete, and some parts showed that the nose of the "S" curve could be passed, as several of the tests under 600 F gave hardnesses which would be expected from true austempering. This established the fact that the low side of the quenching range of temperatures could be critical and, in effect, it gave a limiting lower temperature. At temperatures above 700 F the desired hardness could not be obtained.

These tests were run in furnaces which could be operated on a production basis with good salt recirculation and close temperature control. Water additions were made to the salt in the furnace on some of the tests to provide a faster cooling rate, but this did not change the results enough to make true isothermal annealing possible.

After these tests the parts produced were subjected to extensive testing and microscopic study and were found superior to the normal oil-quenched and tempered product. The next step was to heat treat a test lot of 3000 pieces in this furnace. These were then sent out to the trade for actual field testing. This test lot was pronounced completely satisfactory by the user and a great many of the parts were driven onto the rails several times.

With the final approval of the 3000-piece test lot, the engineering work was completed and salt bath furnaces were ordered and installed. The sketch of one of the furnaces on Figure 5 shows the conveyor location and how the recirculated salt is aimed directly at the part as it drops from the press into the salt. The furnace has both heating and cooling equipment to maintain a constant temperature. This equipment is controlled by instruments which maintain and record the temperature of the salt. Parts can be produced from each press at a rate of 25 to 30 per min, at weights varying from 2.4 to 3.9 lb, depending on the section being used.

The critical part of the design was to provide enough volume of salt and enough cooling capacity to dissipate the heat in quenching the parts from 1700 to 600 F and maintain a constant salt temperature. The conveyor speed was designed to keep the part immersed in the molten salt for three min. This gives quite a factor of safety as the heat treating theoretically takes about 20 sec to be complete. A good many pieces were tested with immersion time of two min and were found satisfactory. Any time in excess of the three min immersion in the salt furnace means a heavier load on the conveyor and serves no practical purpose. The volume of salt in the furnace is 233 cu ft and the salt used as a potassium-sodium nitrate with an operating range of 325 to 1200 F.

After leaving the salt bath the parts are conveyed to a water rinse tank where the water is held close to the boiling point to speed drying. The parts are then conveyed to a sorting table for final inspection, testing, and packaging for shipment. Figures 6 and 7 show the installation and the relative size of the equipment.

With the installation of the first unit at one of the three presses, a great deal more experimental work was done. The temperature of the salt was varied from 600 to 850 F. Due to the good circulation of salt and the extreme agitation where the parts enter the salt bath, the cooling rates were fast enough to produce parts with the desired hardness over the entire range of

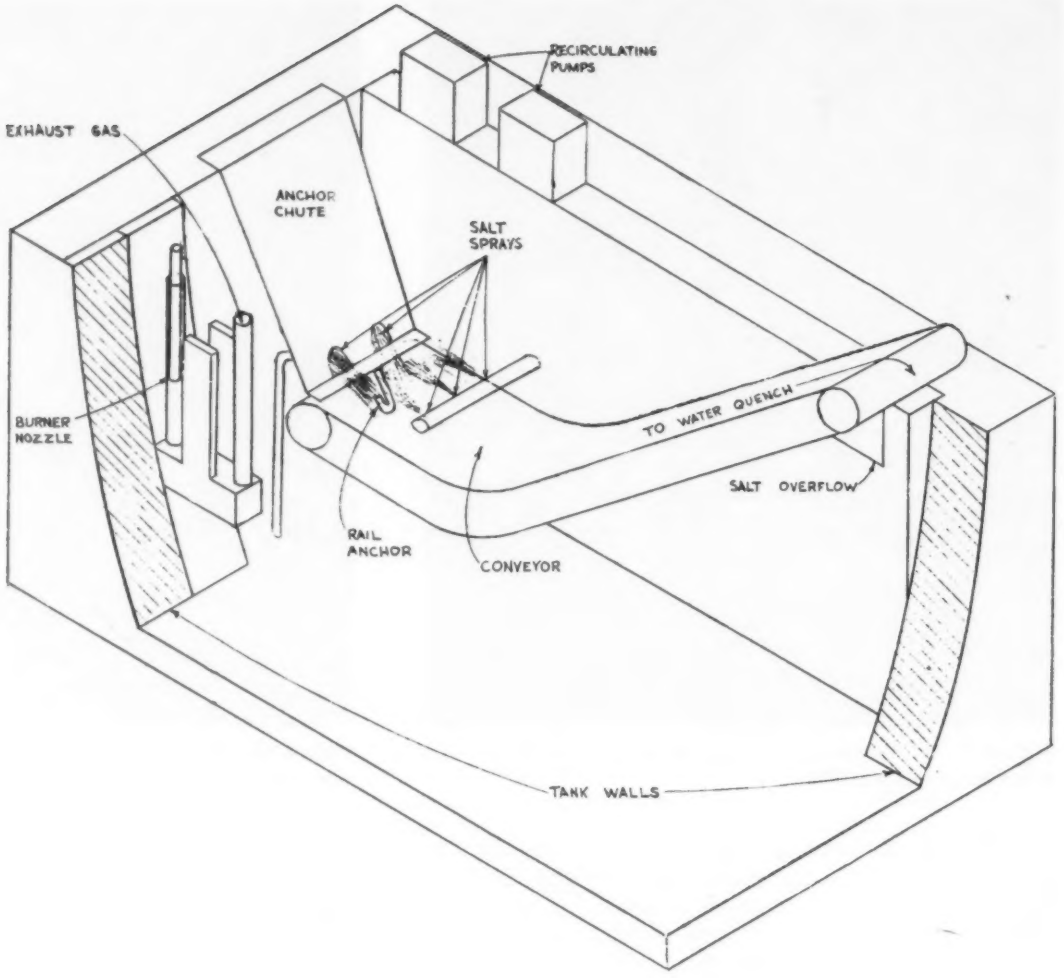



**Figure 5 — Cutaway view of the salt bath furnace shows spray position and salt level.**

temperatures used. When testing parts produced at the various temperatures it was soon discovered that those produced on the higher side of the temperature range contained some brittle pieces which broke when being driven. This led to considerable study but nothing could be detected structurewise under the microscope to account for it. The reason was ultimately found to be temper brittleness which apparently may occur quite rapidly above 750 F and is retarded at temperatures below that temperature.

Not all of the parts produced at temperatures over 750 F were brittle; when brittleness was encountered at sporadic intervals about 10 to 20 per cent of the parts were brittle. The reason why all of the pieces were not affected has not yet been found, but enough trouble was encountered to set the maximum temperature of the salt bath at 700 F. When testing on the low side of the temperature range, it was found that occasional hard parts were encountered at temperatures under 625 F. This established our lower limit of temperature. The salt bath temperature is now being maintained between the limits of 650 and 675 F with very uniform hardness results.

Further testing included the study of the importance of the temperature of the parts leaving the press and entering the molten salt. In the old process of oil quenching this temperature was quite critical as pieces delayed in fabrication and oil quenched from a temperature lower than the usual would not quench completely to a martensitic structure, leaving the finished pieces brittle after tempering. The exact temperature where trouble started was not determined, but 1600 F was felt to be the minimum temperature for entering the oil to avoid trouble.

In the present process this temperature was again found to be quite critical, but for an entirely different reason. Eutectoid steels are austenitic from about 1350 F up and this is a great advantage for this type of heat treating. Parts were tested at temperatures from 1250 to 1900 F. It was found that pieces quenched at 1350 F or below had soft spots and generally were below the desired hardness range, but as long as the steel was austenitic the finished parts were good. A good many pieces were quenched from 1400 F, and all were completely satisfactory, which removed another variable which had caused trouble in the previous heat-treating process. The critical quenching temperatures were found to be the higher ones.

The heating furnaces used to heat the blanks before forming had never been a problem in the oil-quenched and tempered process, but it was found possible that due to delays during operation the blanks could be overheated to above 2000 F. This causes grain coarsening in the steel which is not refined in the heat-treating process. The resulting product will not withstand the drive test, the extent of the brittleness again being 10 to 20 per cent of the parts tested. To overcome this difficulty the maximum temperature of the blanks leaving the furnace has been set at 1850 F which does not hamper the forming operation. Considerable education of personnel was necessary to achieve such control, because, to prevent overheating, the furnace

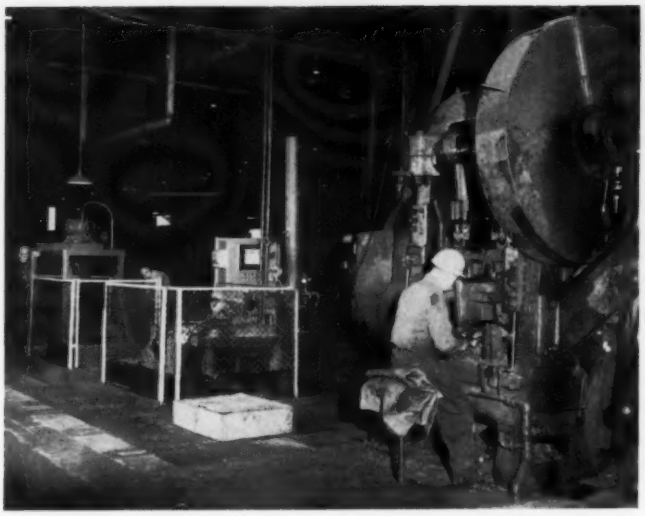


**Figure 6 — The parts are formed in a press at the rate of 25 to 30 per min.**

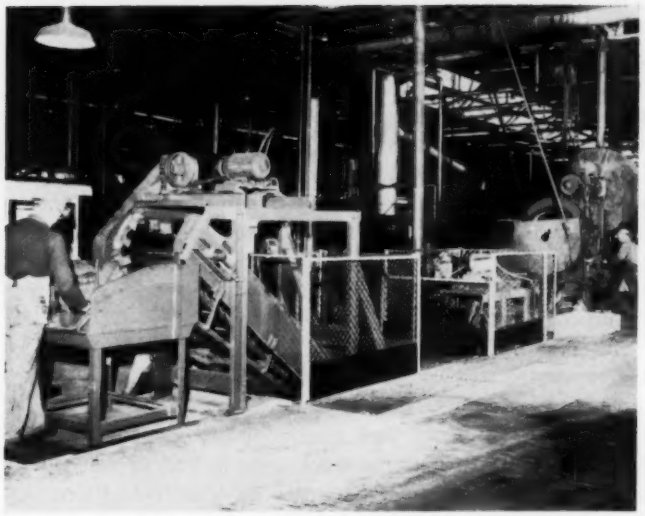


**Figure 7. — Installation of the salt bath furnace and water quench resulted in a higher quality product.**

must be cut back immediately when delays occur. Most of the trouble encountered in testing the finished product can be traced directly to furnace delay.

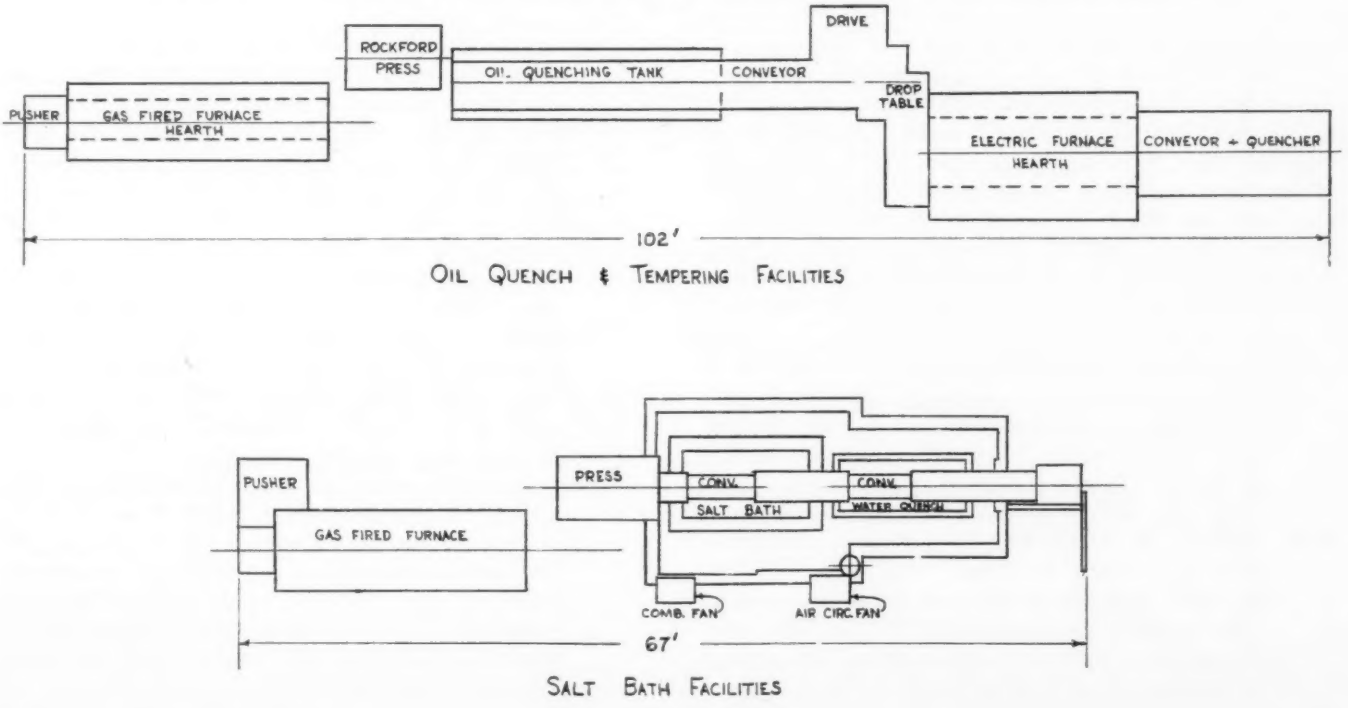
Once the preliminary testing was completed the unit was released for full production purposes and the other two salt furnaces were installed. Some further testing was done on a full production basis. During the 3-min immersion time in the salt furnace 80 to 90 parts can be produced. These are lying on the conveyor piled three to four deep. There is considerable metal-to-metal contact and there was some concern that this might retard the cooling rate and cause soft spots or soft parts as a result. Four times a turn for the first several weeks of full operation, 60 pieces in succession were checked for hardness. The uniformity was excellent and we were relieved of that worry. At the full production level the temperature of the salt was checked by a portable thermocouple, at various locations in the salt furnace, both during slow and maximum production, and found to be within 5 F of the controlling instrument. No evidence of hot or cold spots within the salt furnace could be found.

There have been some maintenance problems with the new equipment which should be mentioned. Scale removal from the furnaces is a problem. The scale is so fine that so far it has defied efficient cleaning. The other main problem is burner maintenance. The burners are used as coolers when not firing and are immersed in the salt. There are some problems in keeping them operating due to clogging with salt.

In summary the present process has the following advantages over the old process:

1. It eliminates the tempering variable which was inherent to the old process, and results in a product with a much more uniform hardness. The hardness is so uniform that the carbon content of the steel can be

**Figure 8 — A reduction in required area was an additional bonus of the salt bath installation.**



plotted versus the hardness obtained in the salt bath furnace.

2. It provides a better control for parts delayed in entering the quenching medium and lowers the critical quenching temperature from 1600 to 1400 F.

3. It produces a part which appears to have better spring characteristics and gives a product with greater longevity for it can be redriven more times.

4. It saves a great deal of space in an already overcrowded area. Figure 8 gives a comparison of the space occupied by the two systems.

5. The installation cost of all three new units was about equal to the cost of one unit under the original proposal.

In conclusion, our purpose in describing this process was not to extoll the improvement in one of our products, but rather to raise questions concerning present heat-treating facilities. If heat-treating can be done isothermally, either by the method described or other methods described in the literature, we feel it is well worth investigating for savings in labor, space and equipment cost, as well as possible improvement of end product, are within the realm of possibility.

## Discussion

PRESENTED BY

**A. A. BRADD, Coordinator of Rolls, Midvale-Heppenstall Co., Nicetown, Philadelphia, Pa.**

**E. W. STOTZ, Assistant Chief Metallurgist, Bethlehem Steel Co., Johnstown, Pa.**

**A. A. Bradd:** In the photomicrographs you showed a lot less free ferrite in the salt bath-quenched piece than in the oil-quenched piece. Am I right in thinking that you have a faster quenching rate in the salt?

Did you find any difference in the amount of distortion after the salt quench compared to the oil quench?

**E. W. Stotz:** When you are dealing with steels at around 0.80 per cent carbon, if they are over 0.80 per cent carbon you get cementite. If they are under, you get ferrite. That could have something to do with the analysis of the steels used in those pictures. I think what you saw in the microstructure of the oil-quenched sample was some cementite in the grain boundaries.

As far as distortion goes, these parts have to meet a certain tolerance in order to fit correctly on rails. In the oil quenched and tempered process it was necessary to make them a little open because they would tighten up after oil quenching and tempering. We found on salt quenching that they are exactly the same before and after the treatment. There is actually no distortion at all. We had a little bit of distortion in the old process which we took care of in forming the part.

When we did produce parts with the wrong hardness level on the old process, we were unable to retreat them because they would tighten up too much and they could not be used for the application involved. In this process when we do produce something outside of the hardness range or have furnace delays, we can retreat the parts without trouble. Thus we have reduced our rejections.

**A. A. Bradd:** Is the quenching rate faster in salt than in oil?

**E. W. Stotz:** I would say it would be slower because you are not going to as low a temperature. You are going to 650 F, or from the same high temperature down to a higher low temperature. ▲

# Available Translations

As a service to readers of the *Iron and Steel Engineer* a list of transactions from foreign articles is being printed intermittently. Articles selected for this listing will be those of primary interest to the American Steel plant operator. The papers may be obtained from the British Iron and Steel Industry Translation Service, The Iron and Steel Institute. 4 Grosvenor Gardens, London, S.W. 1, England. All correspondence concerning price, ordering, and so forth should be directed to that address.

1316 OHTAKE, T., et al: "Causes and Prevention of Surface Fissures of Hot-worked Steel Products." I—"Influence of Heating Conditions, Scaling Loss and Tramp Elements on the Surface Fissures," *Nippon Kinzoku Gakkai-Si*, 1957, Sept., pp. 536–540.

1369 KOHLER, W., et al: "Investigations of Converter Bottoms," *Stahl u. Eisen*, 1959, May 14, pp. 674–683. Practice of the new dolomite plant of the August Thyssen-Hutte A.G., Duisburg-Hamborn. Vibration of converter bottoms through a vibrator plate located above. Composition of unfired and fired converter bottoms. Types of carbon in fired bottom. Operating conditions of converter and their influence upon bottom life. Influence of packing between bottom and lining. Effect of blowing on bottom life. Relationship between quality of steel and bottom wear. Economic efficiency. (Author's summary.)

1376 MULLER-TRIMBUSCH, K.: "First Blast-furnace Gas Turbine Plant at a German Steelworks," *Stahl u. Eisen*, 1959, Apr. 16, pp. 457–463. Contents of this paper include reasons for the installation of the first blast furnace gas turbine plant at the Niederrheinische Hutte: power and blast furnace gas balances, blast and electricity production, and condition of the existing blowers and electricity generating plant. Single working of the gas turbine plant during failure of the public power supply. Cost of plant, acceptance and working experience. Fouling caused by dust. Lack of a suitable, cheap alternative fuel so that blast furnace gas peaks could be used. (Author's summary.)

## TENTATIVE PROGRAM

# Association of Iron and Steel Engineers
# 1960 AISE Annual Convention
# and
# Iron and Steel Exposition

## CLEVELAND PUBLIC AUDITORIUM
## CLEVELAND, OHIO

## SEPTEMBER 27, 28, 29, 30

**"The Heating & Ventilating of a Modern Steel Mill Building,"** by Charles H. Smith, Consultant and formerly Vice President, L. J. Wing Mfg. Co., Div. of Aero Supply Mfg. Co., Inc., Linden, N. J.

**"Gas Fired, Radiant Comfort Heating,"** by J. N. Evans, Superintendent, Fuels and Power, and V. J. Urschel, Heating and Ventilating Engineer, Lorain Works, National Tube Div., United States Steel Corp., Lorain, Ohio

**"The Influence of Preloading by Sand Dunes on Economy of Foundations at the New Midwest Steel Mill,"** by Elio D'Appolonia, President, E. D'Appolonia Associates, Pittsburgh, Pa., and L. A. Fugassi, Chief Engineer, Midwest Steel Corp., Div. of National Steel Corp., Valparaiso, Ind.

**"New Inspection Techniques and Their Effect on the Mill Operator,"** by G. P. Michalos, Superintendent of Inspection, Steel and Tube Div., The Timken Roller Bearing Co., Canton, Ohio

**"Analysis of Today's Tube Welding Processes,"** by Norbert C. Rubin, Vice President, The Yoder Co., Cleveland, Ohio

**"Applying Clear, Mill Type, Pipe Coatings (Methods and Problems),"** by Donald A. Golbey, Sales Engineer, The Cleanola Co., Glenshaw, Pa.

**"Techniques in Rebuilding Open Hearth Furnaces,"** by Carl F. Bessent, Supervisor of Maintenance, Mechanical Maintenance Dept., Bethlehem Steel Co., Sparrows Point, Md.

**"Evaluation of Checker Design,"** by F. D. Nelson, Assistant Superintendent, No. 3 Open Hearth, Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

**"A Comprehensive Method for the Thermal Design of Regenerators,"** by J. W. Hlinka, Senior Research Engineer, F. Puhr, Research Engineer, and Dr. V. Paschkis, Professor, Mechanical Engineering and Director, Heat & Mass Flow Analyzer Laboratory, Columbia University, New York, N. Y.

**"Test Stand Evaluation of Oil Film Roll Neck Bearings,"** by Norman A. Wilson, Manager of Research, and Samuel S. Rickley, Chief Engineer, Morgoil Bearing Dept., Morgan Construction Co., Worcester, Mass.

**"New Methods for Handling Grease,"** by Charles A. Bailey, Lubrication Engineer, National Tube Div., and Donald R. McCaa, Product Manager, Standard Products Dept., American Bridge Div., United States Steel Corp., Pittsburgh, Pa.

**"Oil Mist Lubrication on Antifriction Backup Roll Bearings,"** by C. W. Southerington, Chief Engineer, Dallas Div., Revere Copper and Brass, Inc., Chicago, Ill.

**"A Training Program for Key Electrical Maintenance Employees,"** by Dr. Joseph S. Kopas, Training Counselor, Republic Steel Corp., and Director, Human Engineering Institute, Cleveland, Ohio

**"Maintenance of Electric Power Equipment,"** by John G. Roberts, Power Foreman, Bethlehem Steel Co., Lackawanna, N. Y.

**"Safety for Steel Plant Electrical Man,"** by Jack F. Trenner, Assistant Superintendent Electrical Dept., Bethlehem Steel Co., Sparrows Point, Md.

**"Fundamentals of Heat Distribution and Refractory Wear in Electric Steel Furnaces,"** by W. E. Schwabe, Product and Process Development Laboratory, National Carbon Co., Div. of Union Carbide Corp., Niagara Falls, N. Y.

**"Production Aspects of the Dwight-Lloyd McWane Process,"** by someone from McDowell Co. Inc., Cleveland, Ohio

**"Open Coil Process Makes Startling Changes in Sheet Steel Chemistry,"** by John A. Bauscher, Vice President—Research, Lee Wilson Engineering Co. Inc., Cleveland, Ohio

**"Elimination of a Coke Plant Relief Holder,"** by H. E. Taylor, Superintendent, Coke & Chemical Div., Alan Wood Steel Co., Conshohocken, Pa.

**"Oxygen Steelmaking in the Ajax Furnace at the Appleby-Frodingham Steel Co.,"** by Albert Jackson, Technical Director of Appleby-Frodingham Steel Co., Scunthorpe, and Technical Adviser on Steelmaking, United Steel Companies, Ltd., Sheffield, England.

**"Oxy-Fuel Processes Increase Steelmaking Rates,"** by E. F. Kurzinski, Manager, and R. D. Jones, Development Engineer, Applied Research and Development Div., Air Products, Inc., Allentown, Pa.

**"Analytical Investigation of the Cold Rolling of Bar Stock,"** by Dr. Alvin S. Weinstein, Assistant Professor of Mechanical Engineering, Dr. Carl F. Zorowski, Assistant Professor of Mechanical Engineering, and Frank J. Loss, Research Assistant, Carnegie Institute of Technology, Pittsburgh, Pa.

**"New Automated Structural Rolling Facilities at South Works United States Steel Corp., Chicago, Illinois,"** by V. H. Lindberg, Superintendent, Structural Div., and J. E. Duffy, Works Chief Engineer, South Works, United States Steel Corp., Chicago, Ill.

**"Ceco's Ochiltree Works, Modern Electric Furnace Bar and Merchant Mill,"** by W. B. Jacobsen, Works Manager, Ochiltree Works, Ceco Steel Products Corp., Lemont, Ill., and Lawrence S. Barker, Jr., Project Manager, The Rust Engineering Co., Birmingham, Ala.

**"Electrochemistry in the Steel Industry,"** by E. E. Vonada, Product and Application Specialist, Reliance Electric and Engineering Co., Cleveland, Ohio

**"New Concepts in Power Control Rooms for Steel Mill Drive System,"** by V. E. Verheyden, Design Engineer, Industry Control Dept., General Electric Co., Roanoke, Va., and D. C. Nelson, Plant Electrical Engineer, Jones & Laughlin Steel Corp., Aliquippa, Pa.

**"Static Power Supplies for Ore Agglomeration,"** by M. F. Corcoran, Application Engineer, Industrial Systems Dept., Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

**"5-Zone Reheat Furnace—South Works,"** by George H. Krapf, Division Superintendent, Power Production, South Works, United States Steel Corp., Chicago, Ill.

**"New Approach to Centralized Utility Dispatching at Fairless Works,"** by F. W. Allen, General Foreman Utilities Dispatching, and L. Cizmadia, Fuel Engineer, Utilities Dept., Fairless Works, United States Steel Corp., Fairless Hills, Pa.

**"Waste Heat Boiler Applications at Inland Steel Company,"** by W. M. Douglas, Assistant Superintendent (Power, Steam & Combustion Depts.), Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

**"Observations of the Steel Industry in India and Japan,"** by John L. Young, Vice President—Engineering Technology, United States Steel Corp., Pittsburgh, Pa.

**"Steel Production in Latin American Countries,"** by Gen. Edmundo de Macedo Soares e Silva, Managing Director, Companhia Siderurgica Paulista—Cosipa, Sao Paulo, Brazil, and President, Latin American Institute for Iron and Steel, Santiago, Chile.

**"Report on the Present Achievements and the Immediate Prospects of Development of Soviet Ferrous Metallurgy,"** by Ivan Denisenko, Economist, Economic Research Institute, and Roman Belan, Metallurgical Engineer, Head, Iron and Steel Industry Dept., State Planning Commission, USSR

**"Computers for Industrial Control,"** by R. W. Sonnenfeldt, Manager, Engineering, Industrial Computer Systems Dept., Radio Corp. of America, Natick, Mass.

**"Analog and Digital Techniques Used in Rolling Mill Electrical Systems Design,"** by D. E. Abell, Supervisory Engineer, Systems Control Engineering Dept., Westinghouse Electric Corp., Buffalo, N. Y.

**"Application of Digital Computers for Accounting and Control of Continuous Processing Lines,"** by R. W. Kirkland, Application Engineer, Metal Rolling and Processing Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

**"1800 Degrees Hot Blast from Existing Stoves,"** by W. H. Ceckler, Chemical Engineer, Engineering Dept., H. W. Meyer, Research Supervisor, Research Dept., S. Vajda, Process Design Engineer, Engineering Dept., and N. F. Simcic, Research Supervisor, Research Dept., Jones & Laughlin Steel Corp., Pittsburgh, Pa.

**"Limitations of Blast-Furnace Stoves,"** by T. R. Schuerger, Supervising Technologist, and Dr. J. C. Agarwal, Research Technologist, Applied Research Laboratory, United States Steel Corp., Monroeville, Pa.

**"The Use of Natural Gas in Blast Furnaces at the Pueblo Plant of the CF&I Corp.,"** by John M. Negomir, Practiceman, Blast Furnace Dept., Pueblo Plant, The Colorado Fuel and Iron Corp., Pueblo, Colo.

**"The Next Step in Steel Plant Data Processing,"** by W. N. Spray, Manager, Methods & Procedures, Production Planning Div., United States Steel Corp., Pittsburgh, Pa.

**"Minimizing Pollution from Pickling Lines: Automatic Control of Strip Pickling Bath Composition,"** by C. W. Shingledecker, Research Engineer, Bethlehem Steel Co., Bethlehem, Pa.

**"Steps Toward Coke Plant Automation,"** by N. F. Agnew, Vice President, Femco, Inc., Irwin, Pa.

**September 29—Formal Dinner and Dance—**

# MISCELLANEOUS

## Iron and Steel Exposition

Tuesday, September 27.....10:00 A.M. to 10:00 P.M.
Wednesday, September 28...10:00 A.M. to 10:00 P.M.
Thursday, September 29.....10:00 A.M. to 5:00 P.M.
Friday, September 30.....10:00 A.M. to 4:00 P.M.

## Hotel Accommodations

Hotel reservations should be made direct to the hotel of your choice, giving time of arrival and type of accommodations desired. Reservations should state that they are for the AISE Convention. If they are unable to take care of you, they will forward your request to the Cleveland Convention Bureau, who will place you elsewhere.

## Social Functions

Social functions, including the Formal Dinner and Dance, will be held at The Statler Hilton. Technical sessions and the exposition will be held at the Cleveland Public Auditorium.

## Transportation

Cleveland, Ohio, is readily accessible by all means of public transportation. The Ohio Turnpike offers fast automobile travel.

For those within the 150 to 200 mile radius of Cleveland, it is suggested that charter bus arrangements be made with your local bus company to provide buses for transporting groups from plant locations to the Exposition-Convention.

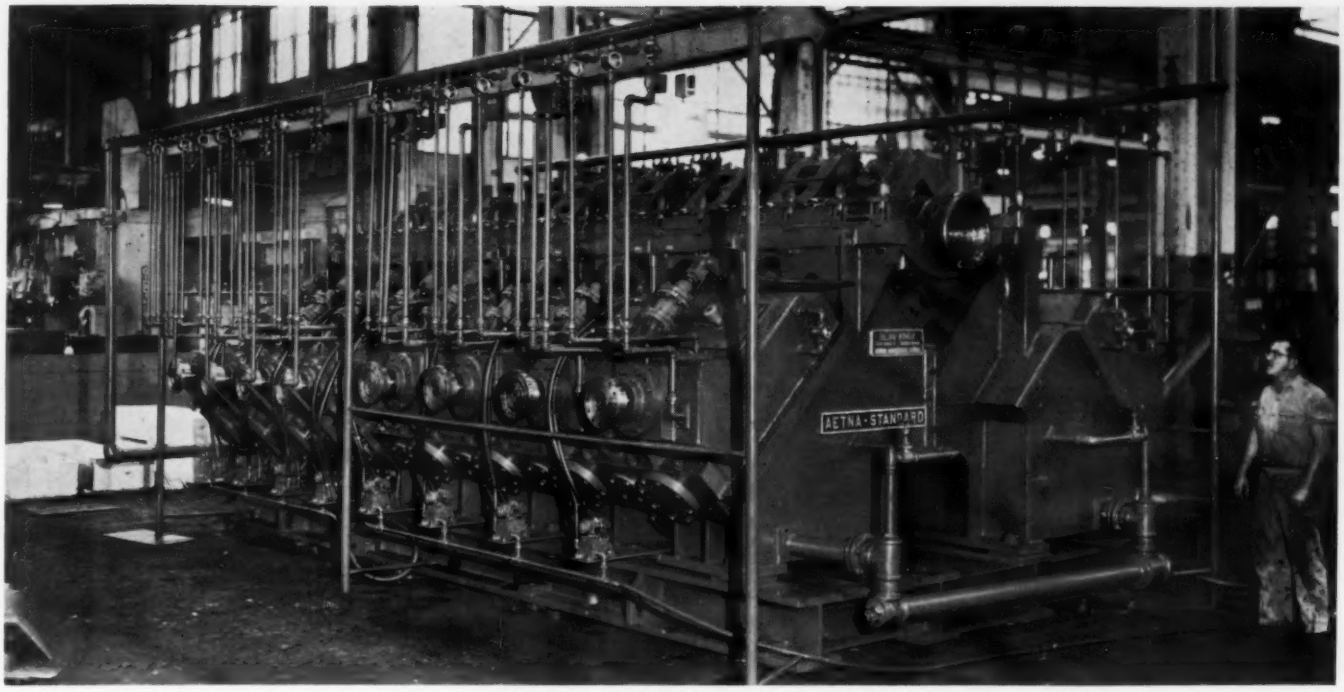



**Figure 1 — Mill is shop assembled with motor and drive spindles removed.**

# New Stretch Reducing Mill Cuts Roll Changing Time

AN interesting development in tube stretch reducing mills, a 16-stand mill is scheduled for shipment by the Aetna-Standard Div. of the Blaw-Knox Co. to Tubos de Acero de Mexico, S.A. (TAMSA) at Vera Cruz, Mexico. The mill can reduce nominal 7-in. seamless tubing to sizes ranging from 1½-in. standard tubing to 5-in. line pipe or casing. This particular mill was designed to satisfy a capacity of 35 tons per hr and a speed of 800 fpm. Operation is scheduled for August, 1960.

The new mill has a unit housing design which differs from the more conventional, older mill. A number of advantages result from this change in design. Some of these advantages are:

1. Closed housing with the rolls between bearings reduce the deflections due to separating forces.

2. Straddle mounting of housing give a more compact and rigid design.

3. The whole roll housing unit is easily removed from the mill and no pulling of rolls from the shaft is necessary. The roll remains in the housing for the life of the rolls.

4. Adjustment of rolls is minimized. Grooving of rolls in the housing insures matched and centered roll grooves.

5. Less downtime is needed for size changes. A special lifting fixture permits vertical removal of the housing blocks. Other features which reduce downtime are: air-operated, quick-disconnnect spindles; quick opening latches; and quick disconnect service hoses.

6. Simplified installation because entire mill, except motors, is on one bedplate.

A special milling machine permits

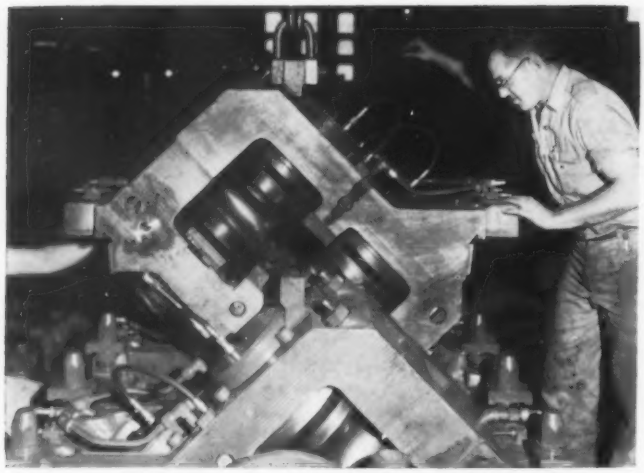


**Figure 2 — Mill crane is used to remove roll housings from mill. Housings for all 16 stands can be changed in 30 to 40 min.**

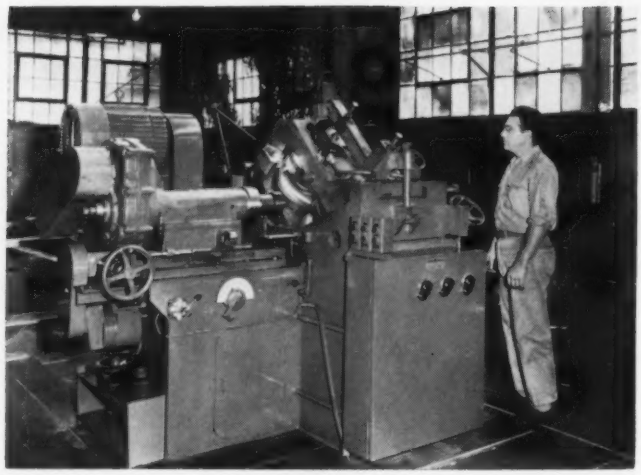


**Figure 3 — The roll grooving machine takes housing unit on same surfaces as it fits into the mill. Milling head is fixed at pass line.**

redressing the grooves in the rolls without taking them out of the housing. This design feature provides substantial savings in downtime for roll changes and in redressing the rolls, and also avoids the hazard of repeated adjustments in the settings of the rolls. The housing unit fits into the grooving machine on the same surfaces as it fits into the mill and the milling head is permanently fixed at pass line. By varying the distance from the end of the cutter head to centerline roll, an oval groove of the proper contour can be generated. The advantages of the new design are:

1. Less machining time. The high speed milling head and simple setup procedure reduces roll dressing time from four to $\frac{3}{4}$ hr. This is based on regrooving from one groove to the next larger groove in the sequence and includes tool changing time. Two rolls are dressed at one time.

2. The grooving machine guarantees that every groove is exactly centered on pass-line and the both rolls are perfectly matched with no offsets between top and bottom rolls. The groove contour is generated automatically. The only adjustment required is on the depth of cut. ▲

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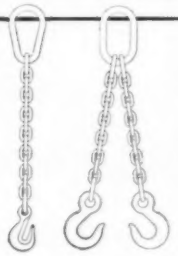

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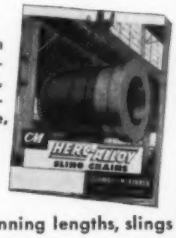

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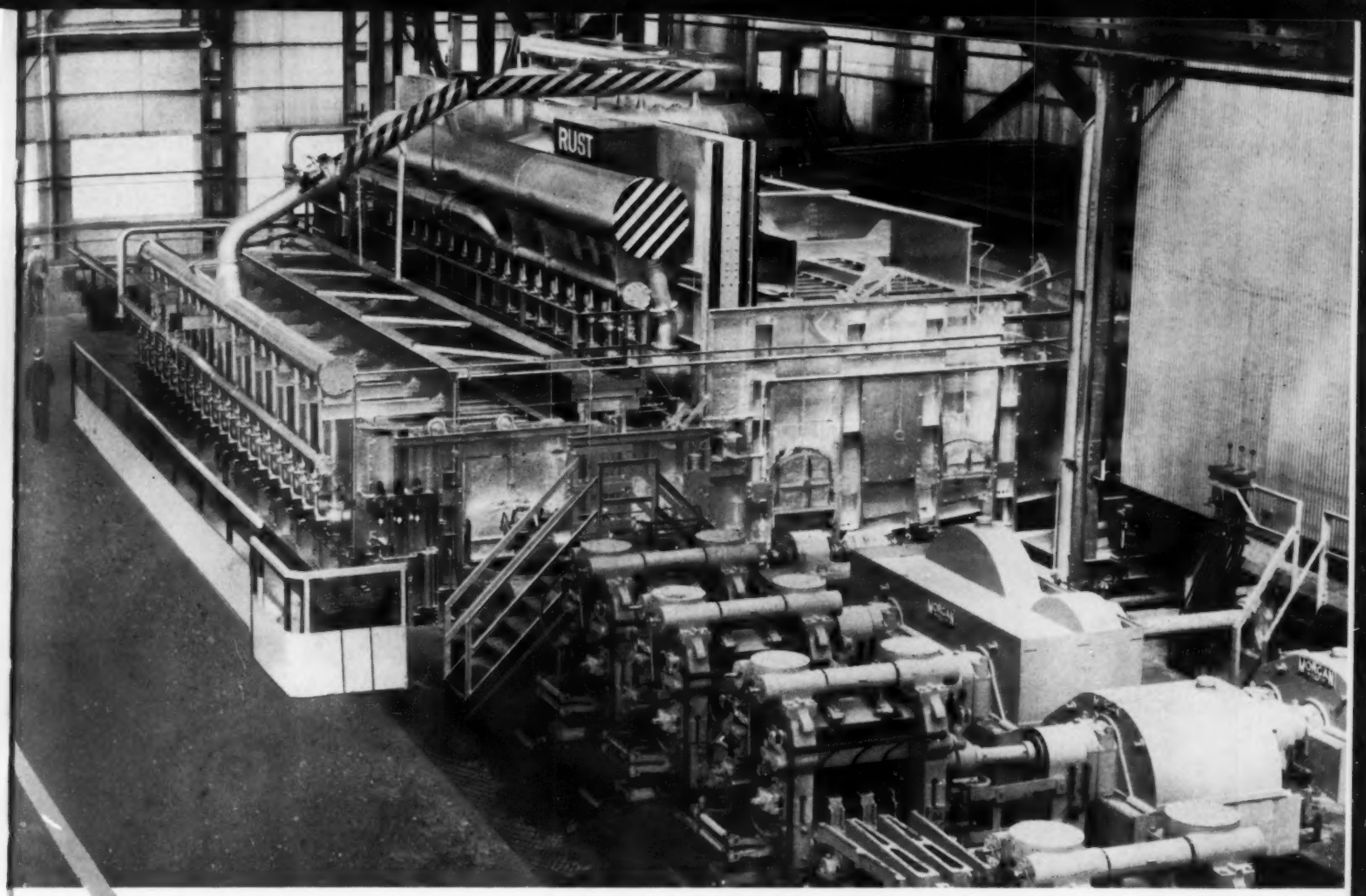
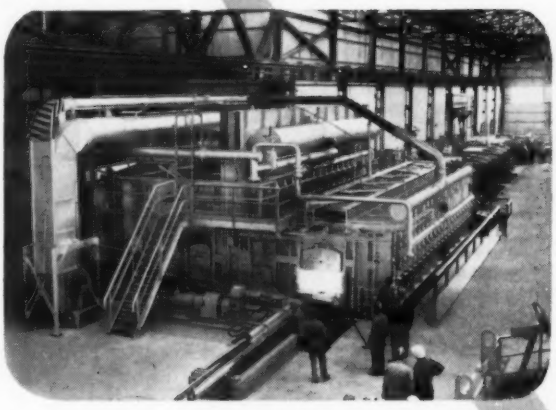



# Two-Zone Continuous
# Billet Reheating Furnace

*for Sheffield Division, Armco Steel Corporation*



• *View from peel bar side of furnace looking toward mill.*

This double-fired, two-zone furnace was designed and constructed by Rust to reheat billets in one of the fastest 10″ rod mills in the world. The mill itself was constructed by The Rust Engineering Company for Armco Steel Corp., Sheffield Division at Kansas City, Mo. The furnace is oil-fired and has a rated capacity of 112 tons per hour.

Since 1927 Rust furnaces have been recognized throughout the world for their rugged design and dependable operation.

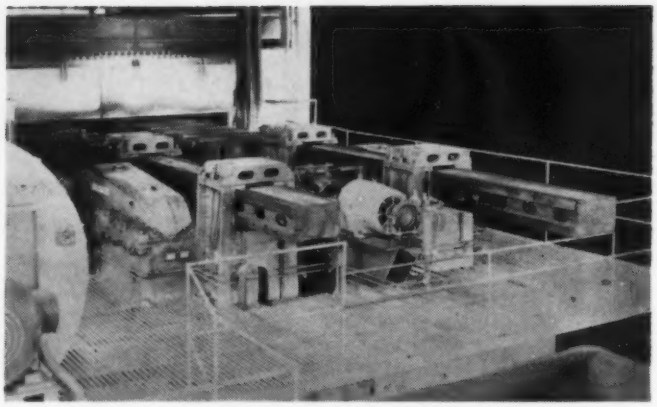
## RUST FURNACE COMPANY

930 Fort Duquesne Boulevard, Pittsburgh 22, Pa.

*First in Heating Efficiency ...* *Pioneers in Furnace Design*

F-27

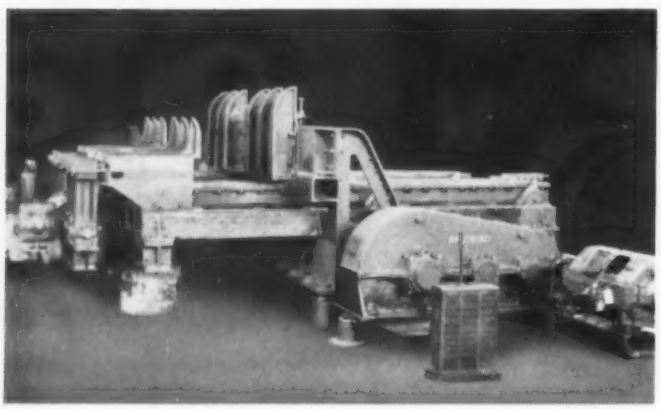
Ram type furnace pusher at shop assembly, made for double or single row pushing of end charged furnace.



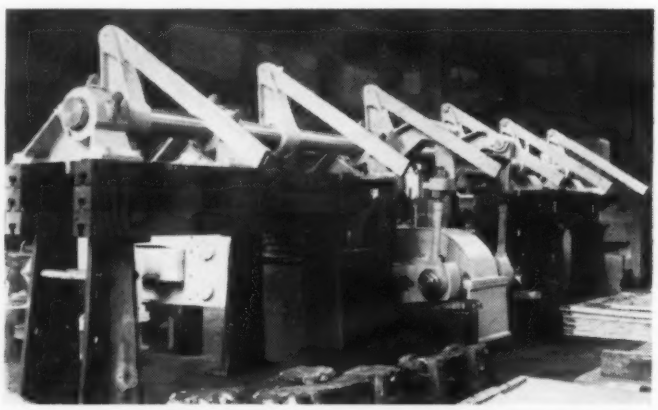
Ram type pushers with clutch for pushing single or double rows of 12" x 12" blooms in end charging furnace.

Single hydraulic type pusher. Billets are charged on raised skids by crane and turned down in front of dogs.

Double dog type furnace pusher. Blooms are placed directly on feeder bed by crane. First set of dogs advances blooms to pushing position. Second set of dogs pushes blooms through furnace.



Slab furnace pusher with depiling magazine. Crane places pile directly in magazine and pusher strips slabs off the bottom and pushes into furnace.



Bar type pusher for pushing side charged furnace.

**Furnace Pushers by**

MM 86-60

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# Rotoblasting Billets Helps Inspection

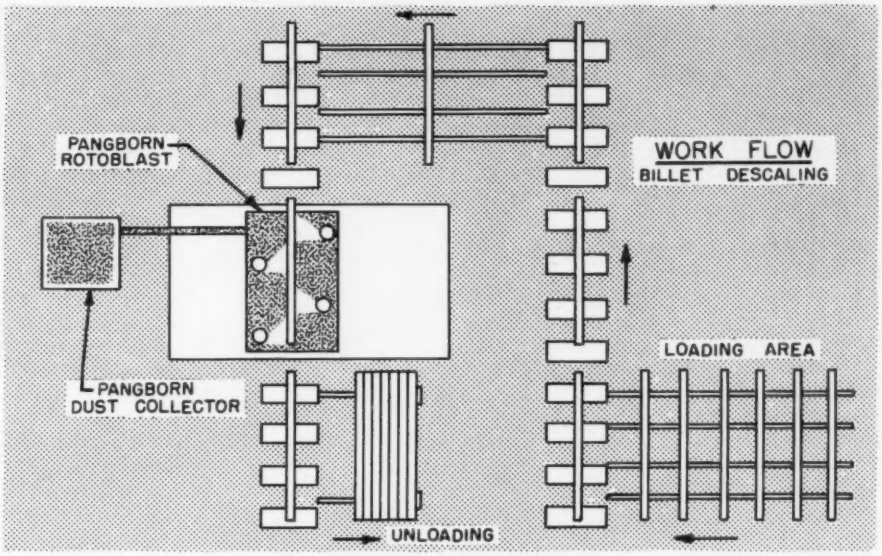



**Figure 1 — Billet flow diagram.**

SPECIAL shot blast equipment is now playing an important role in the quality control of steel by descaling billets right down to bare metal, exposing cracks to facilitate inspection for flaws. Steel companies using this process are able to provide perfect steel for forging into sucker rods, rivets, nuts, bolts, bars for special uses, gears, couplings and other products where dependability is of major importance.

The descaling plant shown in Figure 1 is a rapid automatic process manufactured by Pangborn Corp., Hagerstown, Md. The particular installation shown here uses crane handling of billets to and from the descaling operation. A variable-speed, pushbutton controlled conveyor system feeds the shot blast machine at rates up to 40 billets (30½ tons) per hour. (Where needed, higher production models, of course, are available.)

Six different speed settings are used. Speed through the machine depends on the analysis of the steel being cleaned. High carbon and chrome percentage results in scale of greater tenacity and toughness which requires somewhat slower line speeds.

Blast action occurs only when the billet is moving into and through the blast area. Rotoblast operation is activated by the billet as it trips a lever on entering the blast cabinet. Another lever turns off the blast action as the billet clears the exit end of the cabinet.

An air-jet blowoff prevents abrasive carry-out at the exit end of the cabinet.

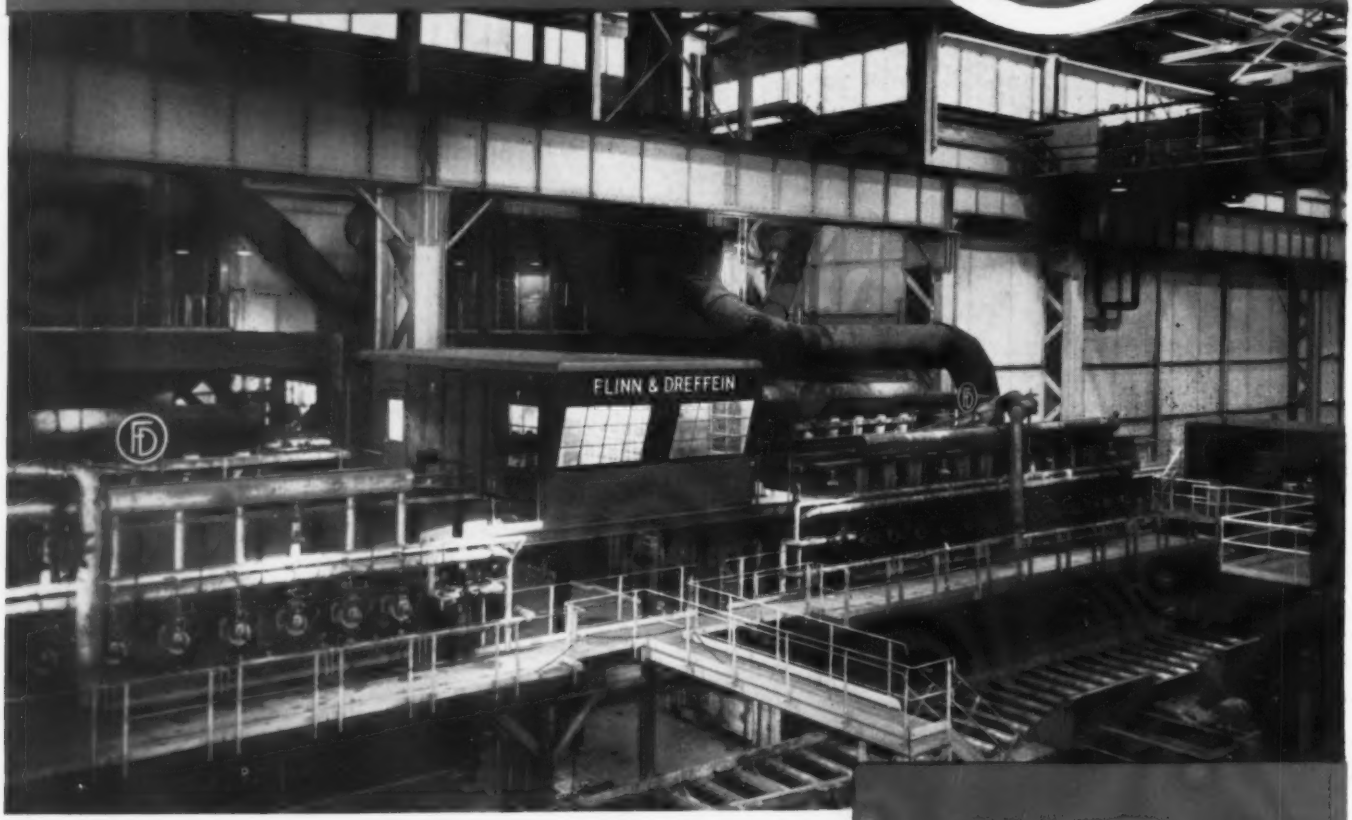
According to steel company supervisors, quality of the blast descaling is "just right"—all loose scale is removed to expose cracks and flaws for easy inspection. Over blasting, on the other hand, would peen over and hide cracks. With the variable speed conveyor, the right degree of blast is easily regulated.

The special blast machine employs four airless wheels using controlled centrifugal force to hurl a total of 140,000 lb of steel abrasive per hr. Wheels are mounted at 45 degree angles to the work, to provide complete and effective all-over blast of the work to be cleaned. Abrasive is recycled by means of gravity to a hopper below the blast area and then proceeds by a belt-bucket type abrasive elevator, to two high efficiency abrasive separators and then moves into a steel plate abrasive bin for use over again by the wheels.

The equipment is reported efficient and trouble-free. Maintenance costs are extremely reasonable. ▲

**Figure 2 — Billet emerges perfectly descaled. Rotoblast shuts off until set in action again by the next billet in line.**

# . . . another first by Flinn & Dreffein . . .




Two new "Flinn & Dreffein Designed" 5-zone reheat furnaces made news recently when they were placed in operation at the new structural mill of United States Steel Corporation's South Works plant at Chicago.

The demand for larger sections, tonnage capacities and flexibility of heating operation dictated this advanced design.

Once again, Flinn and Dreffein experience and know-how reflected by user's confidence inspired Flinn and Dreffein engineers to further the development of reheat furnaces using the latest techniques and materials in furnace design.

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**Figure 1—New breakers with stored energy and ironless blowout are believed to afford faster fault interruptions and faster contact closing, lower weight and smaller size than comparable equipment available in the 4160-volt field.**

# Stored Energy Closing Featured In Circuit Breaker Redesign

A COMPLETELY new design of 4160-volt circuit breakers and switchgear has been announced by the switchgear division of I-T-E Circuit Breaker Co., Philadelphia, Pa.

The breakers combine stored-energy closing and ironless blowout, afford faster fault interruptions and faster closing of contacts, and smaller size than any other comparable equipment available today in the 4160-volt field.

The result is a major advance in terms of improved fault protection, increased safety for personnel and equipment, higher reliability, easier handling and much simpler installation, maintenance and service.

The types of switchgear construction available include the conventional indoor arrangement, and two types of outdoor configurations—standard enclosed and full walk-in.

Major advances of the new circuit breakers include:

1. *Stored-energy closure*—employing a motor-charged, spring-powered mechanism which provides faster closing of contacts, enormously improves contact life and affords far greater safety for personnel.

2. *Ironless blowout*—which provides a significant reduction in arc chute weight for easier handling, and faster fault interruptions through the improved arc extinction afforded by better magnetic field distribution.

3. *Compact size, low center of gravity*—which permits smaller over-all size of switchgear and far easier and safer handling during installation and service. Because of its light weight, the breaker can be handled by a single person for maintenance.

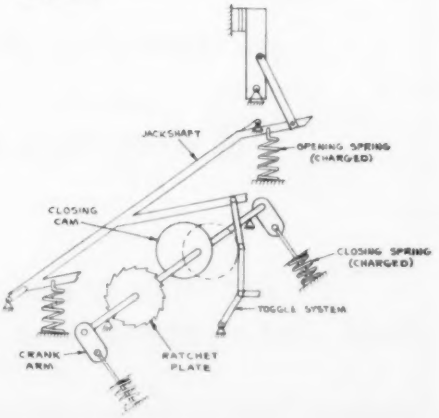
The new switchgear construction also incorporates design advances:

1. Closed-door drawout.
2. Reduced size.
3. Rigid construction.
4. Improved bus and wiring design.
5. Closed-door indication.
6. Easy access to current transformers.

## STORED-ENERGY CLOSING

Extremely fast contact closing,

**Figure 2—Closing springs are charged through a ratchet and pawl system either manually or by a small a-c/d-c motor, and the springs are held in charged position by a set of latches.**



provided by the stored-energy closing principle, has been incorporated to improve contact life and afford greater safety for personnel and equipment.

A high power spring, with a wide safety margin, stores energy supplied to it by a high-torque motor charging through a simple ratchet and pawl system. The spring holds the energy until called for by an operator or automatic control system. Closing power is stored in the spring and one closing operation is automatically available even after control voltage has been lost. The excess energy not used in a closing operation is stored in the spring as a partial re-charge for its next operation.

The spring stored-energy system is inherently faster than any other type of mechanism and does not introduce or cause hesitation in action. Because the system is positive in action, involving no gravity action, the breakers may be operated in any physical position.

The motor and ratchet arrangement provides simplicity and long life. The skip-tooth ratchet allows free-wheeling so that the motor coasts to a stop and is not subjected to sudden jolts or shocks produced by sudden stops. The system uses no clutches or brakes and introduces no complicated motor cutoff problems.

Constant contact closing force is also assured by the stored-energy approach, and springs can be manually charged for emergency closing. Manual closing is available with the door closed by using a lanyard tied to the manual closing hook. For maintenance purposes, with breaker outside the compartment, contacts can be slow-closed.

Control power requirements have been cut drastically—to about one-tenth of the current required by other types of actuating systems. Control voltage can be supplied from any normal lighting circuit—such as 115 or 230 volts alternating current, or from a 48- to 250-volt d-c supply.

### IRONLESS BLOWOUT

Face-wound blowout coils—one of the most radical advances in the new breakers and in the circuit breaker art—provide manifold advantages. They include faster, more efficient interruption without the time lag that occurs when iron is used. This results in far less deterioration of the entire interrupter system, and smaller, lighter weight arc chutes. The chutes can be tilted easily for contact inspection and maintenance, and they snap off easily and can be carried by one man.

The light-weight coils produce a high-flux-density, uniformly distributed, in-phase field which pulls the arc up into the chutes faster—to cut interruption time, increase contact life and reduce erosion of chutes.

An extremely effective, silent and long-lasting pneumatic puffer-buffer system is incorporated on the new breakers. The puffer provides equally fast, efficient interruption on low-current openings. In reverse, it acts as a buffer to lessen shocks occurring during contact opening.

### BREAKER CONSTRUCTION FEATURES

New design breaker contacts are made virtually maintenance-free, with arcing contact surfaces of high refractory silver alloy—for minimum deterioration under arcing. Main contacts are a silver alloy which provides excellent electrical conductivity. All contacts afford abundant wiping action to insure proper contact.

Adjustment for contact travel is afforded by a screw on the movable bridge. Use of a high-pressure hinge eliminates the need for a braided pigtail shunt—removing a possible source of trouble.

The new breakers fully extinguish arcs within five cycles. Arcs are forced up into extinguisher plates of special ceramic material developed for this application. Arc chutes tilt back by hand for easy inspection of contacts and chute interiors.

Self-alining primary and secondary disconnects are attached to the breakers so that they are accessible with safety. Conservatively designed lockwound, multiple springs on primary disconnects assure good contact.

The three primary lead and arc chute supports are one-piece, high strength moldings of flame-retardant, track resistant polyester glass. This avoids the use of any grounded metal above the chassis. The special polyester exhibits track resistance several hundred times that of ordinary polyester. ▲

*There is a constant demand for copies of "The Modern Strip Mill" published by the Association of Iron and Steel Engineers.*

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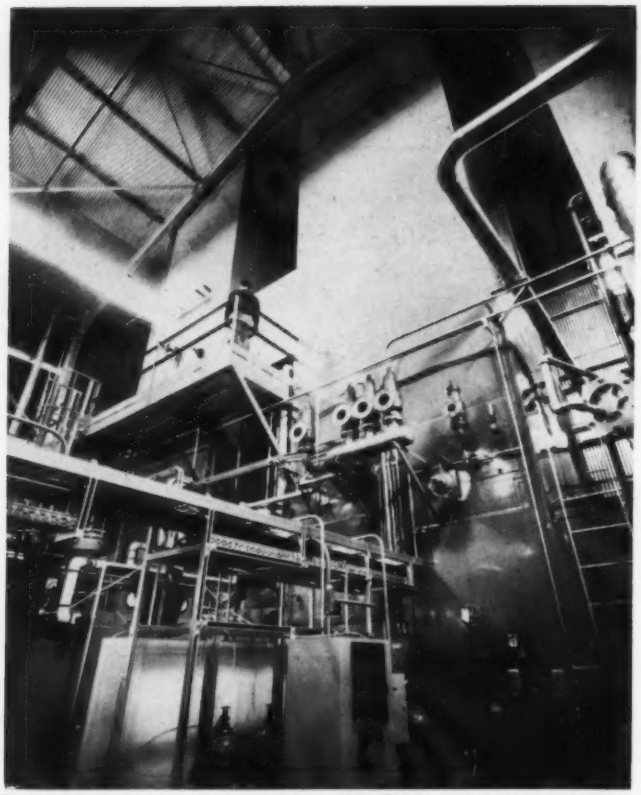


**Figure 1 — Interior view shows Air Reduction's new liquid air separation plant at Butler, Pa., serving the Butler Works of the Armco Steel Corp.**

# Airco Builds Oxygen Plant to Supply Armco

EXECUTIVES of Armco Steel and Air Reduction officially placed on stream Airco's newest "on site" liquid air separation plant at Butler, Pa., on June 16. The plant, which has a capacity of 120 tons of high purity oxygen per day, will supply this industrial gas by pipeline directly to the Butler Works of the Armco Steel Corp. The multimillion dollar, electronically controlled facility, will also produce quantities of nitrogen and liquid argon.

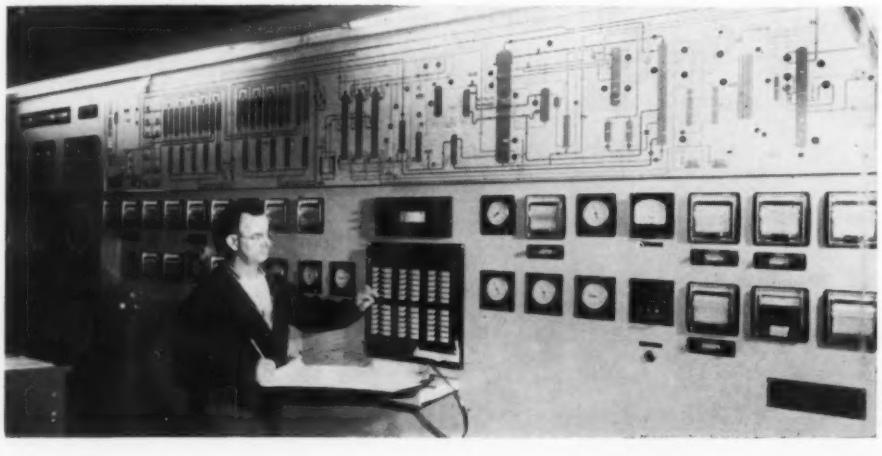
Armco will use the oxygen piped from Airco's new plant for the production of steel in their electric and open hearth furnaces. The combined capacity of Armco's six open hearth and one electric furnace at Butler is over 550,000 net tons of steel ingot per year.

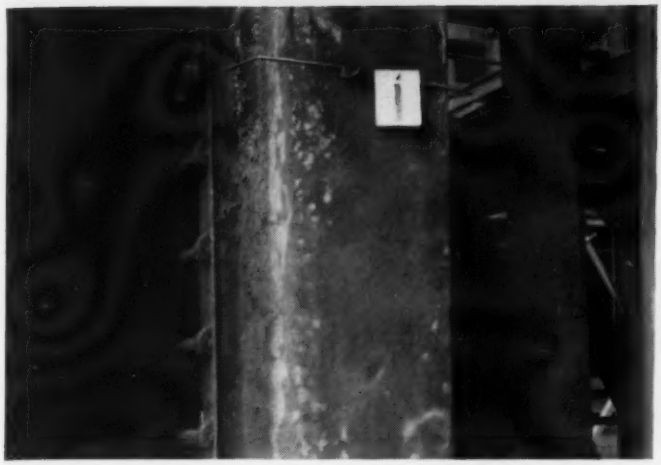
The oxygen is to be used to increase the combustion capacity of the open hearth furnaces and as a direct oxidizing agent to remove impurities from the molten steel in both the electric and open hearth furnaces. In the combustion application, oxygen is fired in special burners mounted either at the sides or ends of the open hearth with natural gas and fuel oil. For use in the steel bath, oxygen is injected by means of a lance thrust through the door of the furnace and immersed in the steel bath.

In addition to these two primary applications, oxygen is used at Armco for scarfing of slabs to remove surface defects before rolling, as well as for general plant maintenance. Nitrogen is also employed in the production of steel at Armco's Butler Works, principally for the prevention of oxidation during the annealing of silicon steel.

The newest Air Reduction facility at Butler is one of four tonnage liquid air separation plants at that site. The gases produced at the plants are distributed over an area with a 500 mile radius. ▲

**Figure 2 — Control panel for the new liquid air separation plant gives complete picture of operations.**





B&W Kaocrete-D, vibrated in place, provides high resistance to the atmospheres encountered in this coke oven door installation. Furthermore, the high erosion resistance and long service life without loss of strength of B&W Kaocrete-D add to its suitability in this application.

A typical monolithic curb wall construction in an annealing furnace using a carbon monoxide atmosphere. The greatly reduced number of joints in which sealing sand can penetrate prevents structural spalling of B&W Kaocrete-A upon heating and cooling. Being monolithic, gas leaks are practically eliminated.

A radiant tube annealing furnace with a base of Kaocrete-A, backed up with Kaolite-20, one of B&W's insulating refractory castables. This furnace operates at approximately 1700 F in a 65% CO atmosphere.

A stack annealing furnace with pedestals cast of B&W Kaocrete-A. The atmosphere is slightly above 8% CO. B&W Kaocrete-A offers strength, volume stability and resistance to carbon monoxide disintegration.

## How B&W refractory castables perform in atmosphere applications

One of the difficult problems facing furnace builders and operators in the metals industries is the effect of atmospheres on refractory linings. That's why B&W offers several *specialized* refractory castables for this service, each possessing strength, volume stability and the refractoriness necessary to assure long, trouble-free service.

Take B&W Kaocrete-A, for example. Because of the careful selection and processing of special aggregates and other ingredients with low iron content, this material resists disintegration or other effects produced by high concentrations of CO or $H_2$ atmospheres. B&W Kaocast and Kaocrete-32 provide the same excellent service at higher temperatures while lightweight Kaolite-20 is outstanding as an insulating castable in atmosphere applications.

*B&W Bulletin R-35A gives additional information on versatile B&W refractory castables. Write for your copy of this bulletin to The Babcock & Wilcox Company, 161 East 42nd Street, New York 17, N. Y.*

R632

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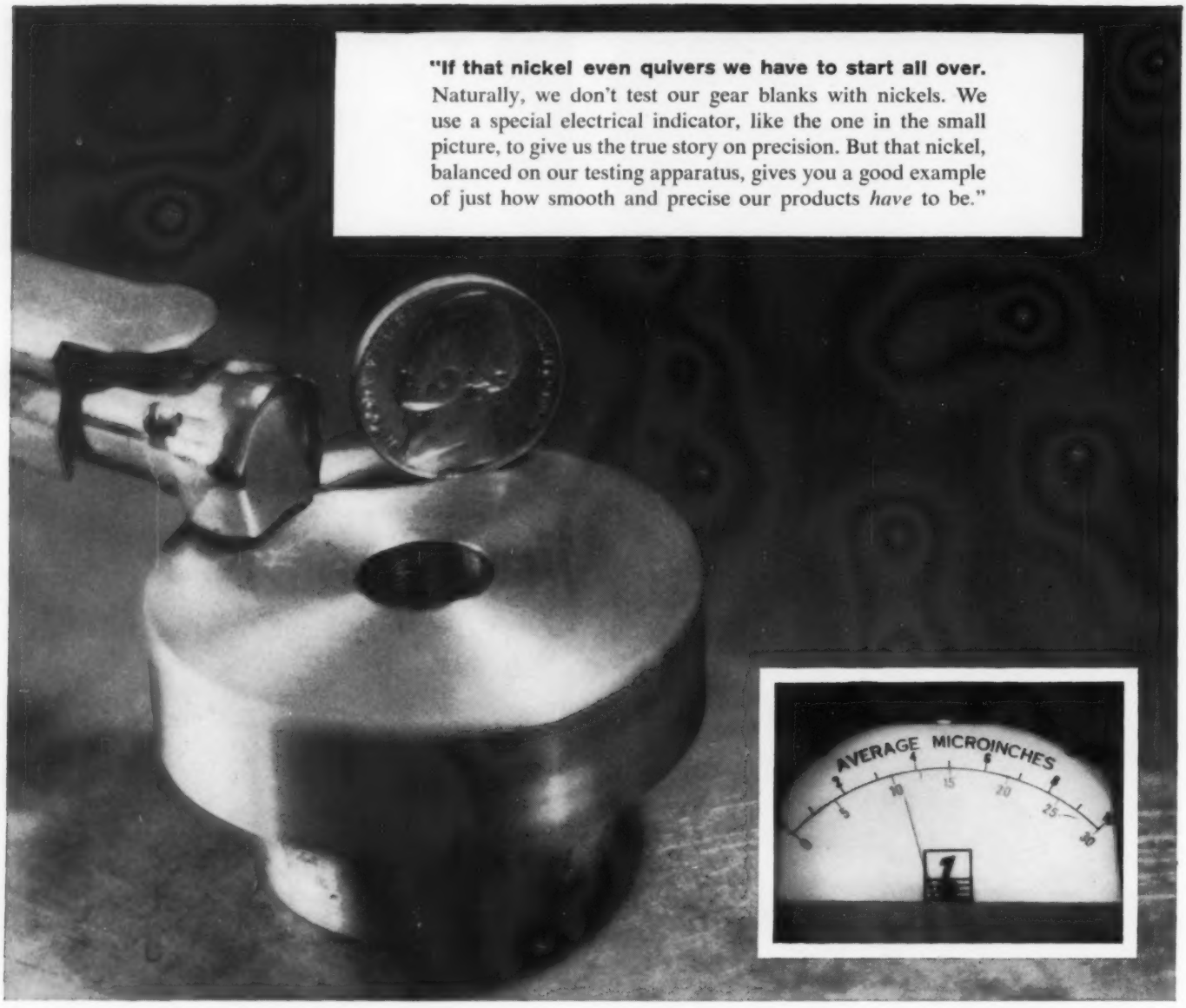
"If that nickel even quivers we have to start all over.
Naturally, we don't test our gear blanks with nickels. We use a special electrical indicator, like the one in the small picture, to give us the true story on precision. But that nickel, balanced on our testing apparatus, gives you a good example of just how smooth and precise our products *have* to be."
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"Matter of fact," says Mr. Hoffmann, "they insisted we try other brands just to prove that Cities Service was the best for us. They proved their point. We've stuck with Cities Service."

At the present time, American Screw Machine Products Co. is using Cities Service CHILLO 10 Cutting oil, and some CHILLO 22. As Mr. Hoffmann says, "The sulphur and chlorine additives prevent welding and galling action which allows for fine finishes and long tool life that maintains high-precision, top-quality work."

If you use petroleum products in your operations, why not talk with your Cities Service Lubrication Engineer? He can help you get the most from your operations by giving you the finest products, the best service available. Or if you prefer, write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

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**QUALITY PETROLEUM PRODUCTS**

# Universal-Cyclops Starts Production in In-Fab Mill

UNIVERSAL-Cyclops Steel Corp., Bridgeville, Pa., has started producing refractory metals of unusually high integrity for future hypersonic aircraft and aerospace weapons in its unique new InFab (Inert-Fabrication) facility.

This facility was conceived, designed and constructed by the Refractomet Division of Universal-Cyclops in technical co-operation with the Department of the Navy, Bureau of Naval Weapons. Its purpose is the production of high integrity mill products of the refractory metals such as molybdenum, columbium, tantalum, tungsten and their alloys.

These metals are currently being produced on specialty steel mill equipment which is far from ideal because their metallurgical characteristics with current practice may not permit the full utilization of the metals inherent properties. Refractory metals should be hot-worked at temperatures double those possible in conventional mills. Molybdenum at these temperatures oxidizes and all refractory metals are contaminated by elements in air. Therefore, it is necessary to prevent contact with normal atmosphere during processing at high temperature. For this reason the InFab enclosure is filled with argon gas which is inert.

The InFab facility is a welded steel enclosure 42 ft wide x 97 ft long x 23 ft high. Inside the enclosure are an impactor, rolling mill, furnaces, a ten-ton crane and space for additional equipment. Forging and rolling of these refractory metals will be performed at temperatures up to 4500 F in the protective atmosphere of argon gas.

InFab's complex respiratory system cools, conditions and purifies the argon atmosphere in the facility to a purity level of 99.995 per cent. This purity level is unique and far exceeds levels commercially available. During operations temperatures in the facility range from 80 to 100 F.

The impactor, rolling mill and furnaces were designed to be fully automatic and are controlled from consoles outside the facility. Each console has a full view of the opera-

**Figure 1 — InFab is a plant within a plant. In it are the rolling mill, impactor, furnaces and space for additional equipment. Outside are the argon purification plant, control consoles and ingot preparation equipment.**

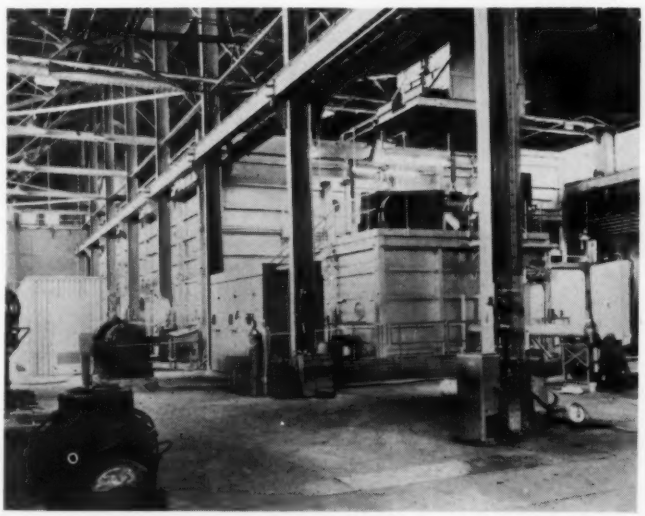
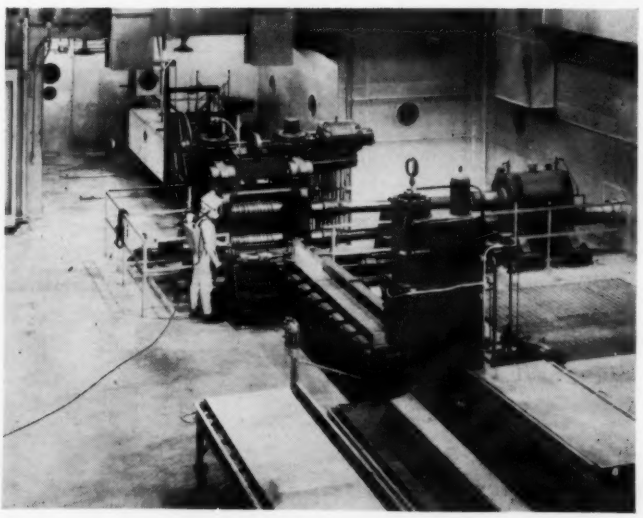


**Figure 2 — Technician watches as molybdenum bar stock is hot worked at 4000 F on the automatic remote controlled rolling mill.**



tions it controls through a special glass "picture window" which shields out harmful ultra-violet rays emitted from the white hot metal.

Some manual handling is required in taking materials into the facility and transferring them between the equipment. This is accomplished with the aid of the ten-ton crane.

It is planned to conduct experiments on hot machining and welding of these materials within the facility in the near future. These functions require personnel to be inside the room.

The InFab technicians are dressed in a modified design of future space suits. It is a four-layer gas-tight suit with an outer garment which provides shielding from thermal and ultra-violet radiation. The technicians carry their air supply and a cooling unit on their back. Once within the facility, they connect their communications and power supply line into conveniently located outlets.

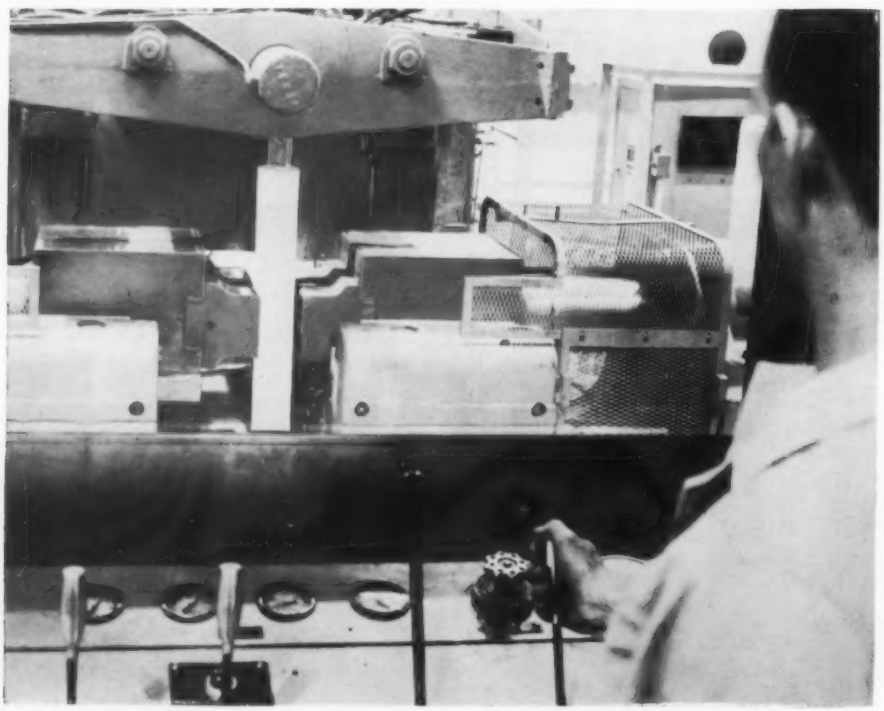
Men, material and equipment move in and out of InFab through three specially designed locks. The locks are vital to the maintenance of the extreme argon purity required and to keep the loss of argon gas to a minimum. The argon is maintained at a pressure just above atmospheric to prevent contaminating air from leaking in. Two personnel "crash" doors are built into the facility. Other precautionary features are included to ensure the safety of personnel.

The refractory metals, formed from metal powders by compaction and sintering into electrodes, are melted into high-quality ingots in a specially designed consumable-electrode vacuum arc furnace. The furnace produces 12-in. diam ingots, 70 in. long, weighing up to 3000 lb. Additional Universal-Cyclops facilities permit the preparation of 16½-in. ingots of the same length and weighing approximately 6000 lb.

It is in the next steps for producing mill products through forging and rolling, that InFab departs radically from past practices. Under the force of the horizontal impactor, ingots are broken down into billets or sheet bar at temperatures up to 4500 F in the protective argon environment. The fully automatic, remote control impactor hits the ingot on two sides with 15,000 ft-lb of force. Since deformation takes place equally on both sides of the ingot, more uniform billets and sheet bars are obtainable.

The ingots are heated in induction furnaces located immediately below the forging zone. The close proximity allows the transfer of the ingots into forging position in two seconds and keeps heat losses to a minimum. The normal product of the impactor will be 4-in. round-cornered square billets and sheet bars 2 by 10 in. in cross section.

**Figure 3 — Automatic impactor is a horizontal forge which delivers an impact of 15,000 ft-lb.**



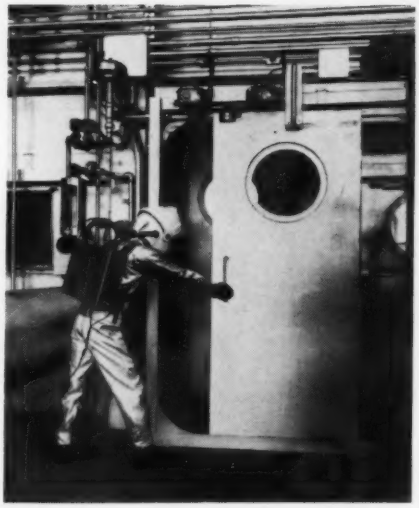


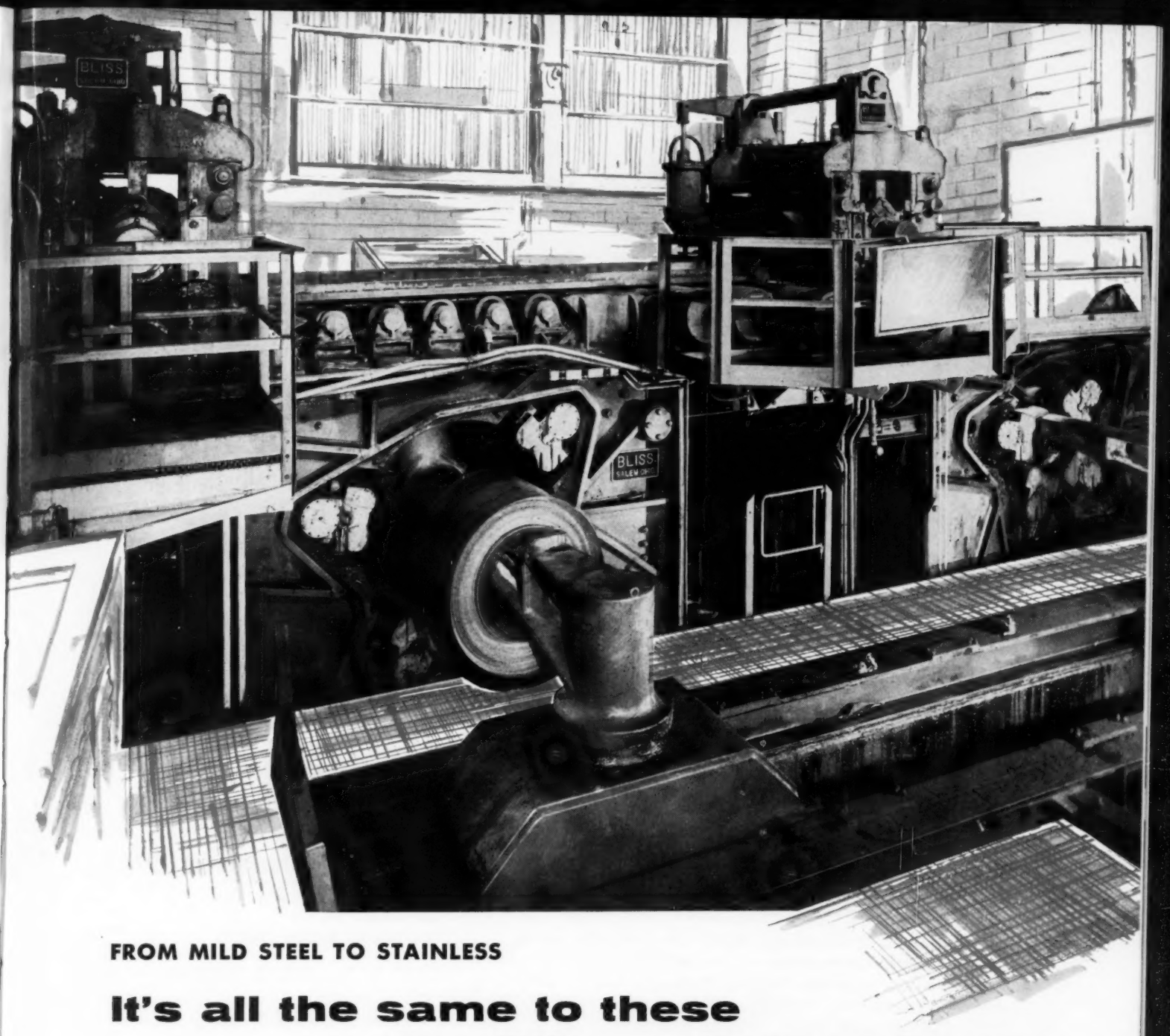
**Figure 4 — Technician enters plant through specially designed personnel lock. Oxygen supply and cooling unit are contained within the pack on his back.**

If further processing is desired, the billet and sheet bar will be transferred to the rolling mill area. They are then heated in a graphite-lined, indirect induction furnace at the end of the rolling mill table. A molybdenum liner inside the furnace protects the metal from reaction with the graphite.

The InFab rolling mill will roll refractory metals into bar and sheet at temperatures up to 4000 F as compared to conventional rolling practices where steel is rolled at temperatures up to 2300 F. The rolling mill is operated from a console outside the facility; motorized roll tables and associated equipment such as the alligator shear, bar turner and pinch rolls permit fully automatic operation.

The two-high 16 by 36-in. mill resembles a miniature blooming mill in many respects. It is equipped with both flat and grooved rolls and can produce bars down to ½ in. diameter and sheet up to 15 in. wide and 96 in. long. Through pack rolling, sheet gages of 0.020 in. will be obtainable.

InFab's fabrication conditions will permit the elimination of many conditioning and annealing operations necessary under current processing practices. It is anticipated that higher product yield and reduced number of processing operations may permit the production of superior refractory metals and their alloys at the approximate cost level of those exotic metals now commercially available. ▲




**FROM MILD STEEL TO STAINLESS**

# It's all the same to these two Bliss coilers at Armco

These smooth-running Bliss downcoilers on the new 56" hot strip mill at Armco Steel Corporation's Butler, Pa. Works, coil everything from flexible mild steel to tough, springy stainless steel strip. Bliss coilers, with their expanding mandrels and positive wrapping action were used because of the variety of gages and alloys to be put through the new mill. In the Bliss design, the mandrel keeps the strip in tension during coiling; wraps a tight, smooth-edged coil without surface scratches or marks. Blocker rolls retract as soon as leading end has been snubbed on the mandrel, and don't move in again until the trailing end is coming through the pinch rolls.

Besides the two downcoilers, Bliss' Rolling Mill Division designed and built the 100-yard-long runout table as another contribution to the Butler Works' handsome new hot strip line. For other examples of Bliss engineering for the ferrous and nonferrous industries, why not write for a free copy of the new profusely illustrated 84-page Bliss Rolling Mill Brochure, Bulletin 40-B? It describes the operation of Bliss mills and auxiliary equipment.

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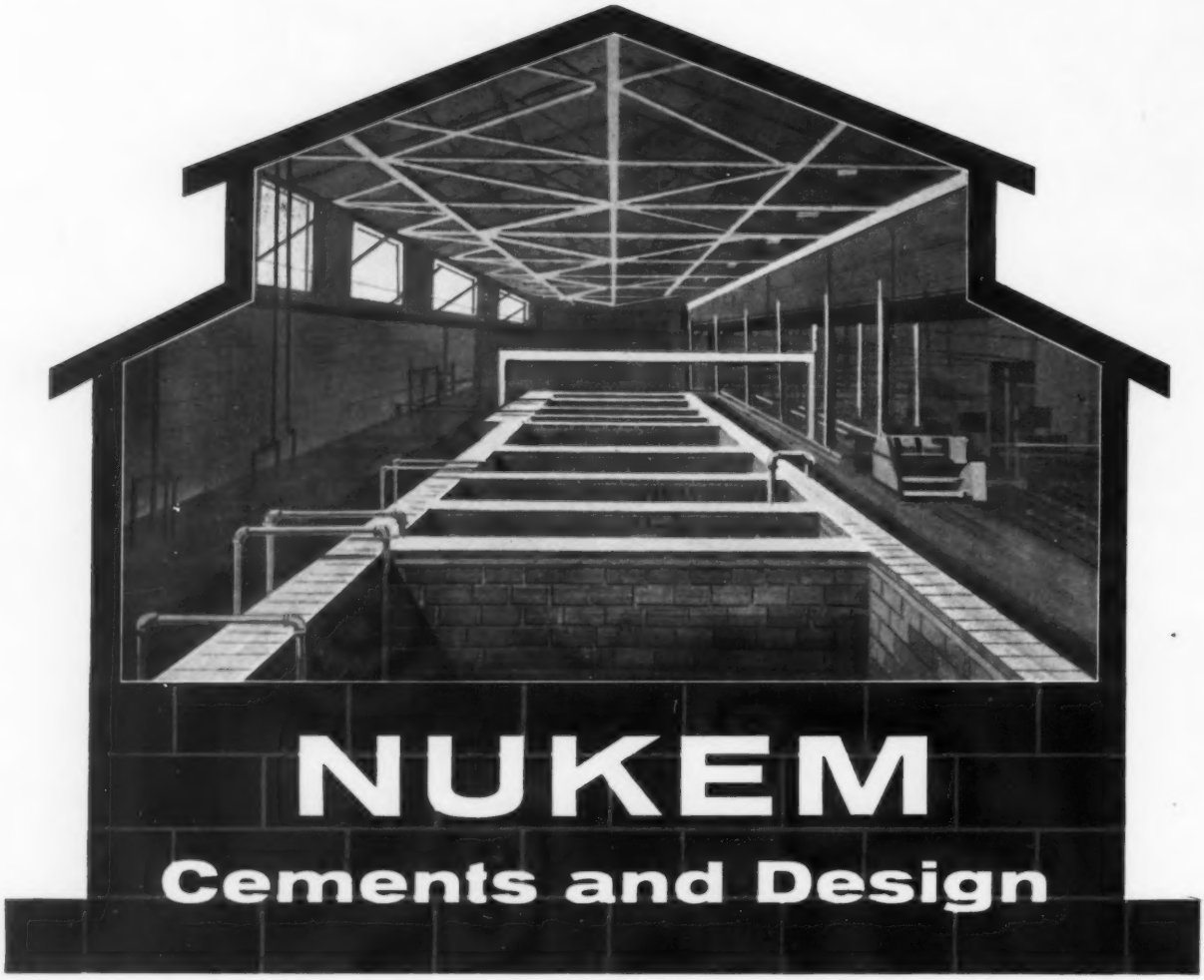
**Subsidiary: The Matteson Equipment Company, Inc., Poland, Ohio**

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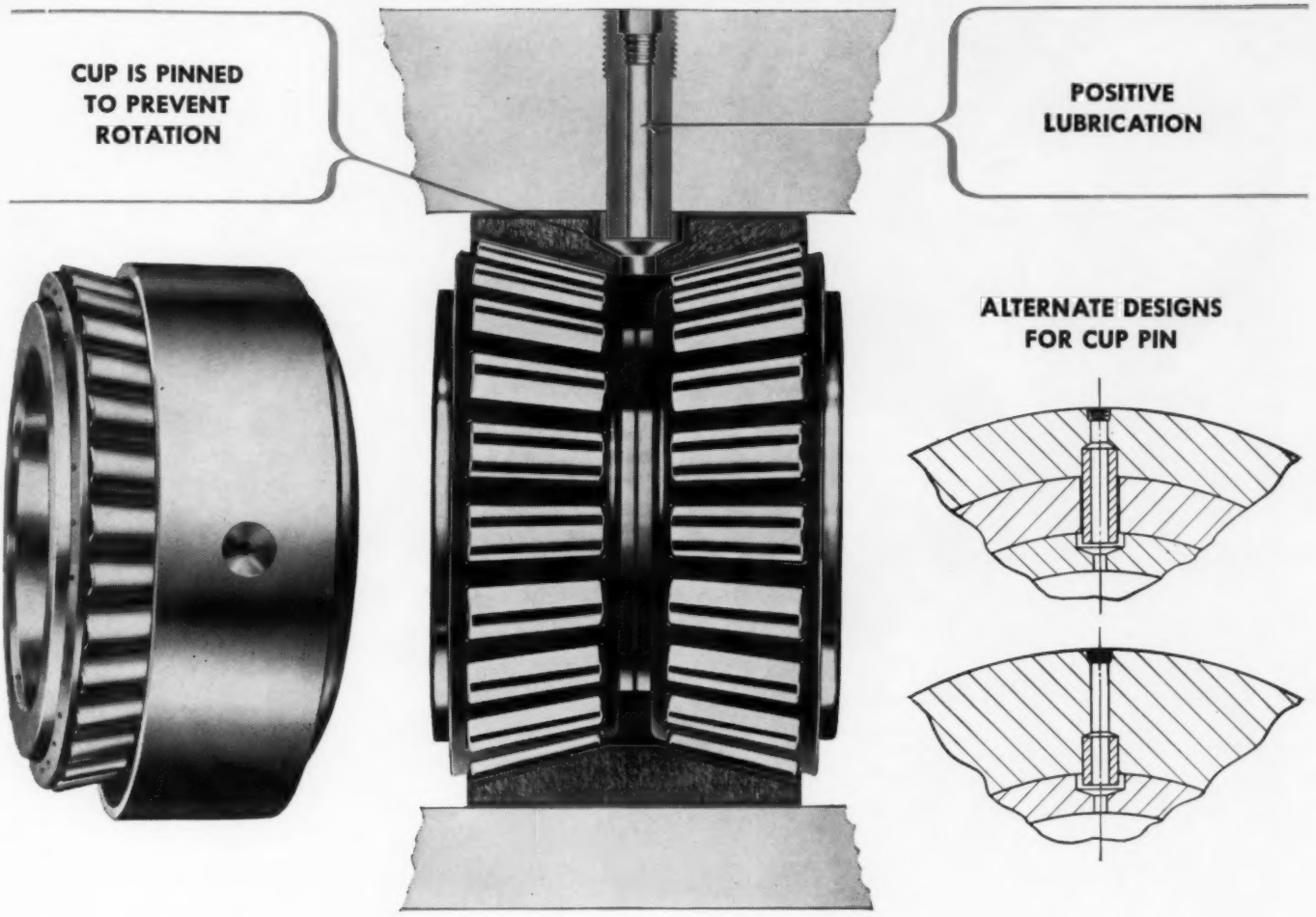


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# Date-line Diary...

*June 1*

△ Joint report of the American Iron Ore Assn. and AISI indicates receipts of iron ore and iron ore agglomerates in the U. S. in April, 1960, totaled 8,084,295 gross tons compared with 5,852,084 tons in April, 1959. Stocks on hand on April 30, 1960, amounted to 32,645,237 gross tons compared with 32,816,353 tons on April 30, 1959. Some 203 of the total 258 U. S. blast furnaces were operating on April 30, 1960, compared with 230 going on April 30, 1959.

△ U. S. Dept. of the Interior, Bureau of Mines reported that production of pig iron in January, 1960, totaled 7,830,097 short tons, steel ingots produced totaled 12,049,404 short tons. Total consumption of pig iron amounted to 7,857,381 short tons, scrap used amounted to 7,856,541 tons.

△ Steel scrap prices dropped approximately $3.00 a ton in Pittsburgh; in Chicago, a major mill reduced its price for prime scrap to $31.00 a ton, off $11.00 from the January, 1960, level.

△ American Iron Ore Assn. reports that shipments of iron ore down the Great Lakes in May, 1960, totaled 12,486,324 tons compared with 12,765,446 tons in May, 1959.

*June 3*

△ Federal Reserve Board approved discount rate reductions to 3½ per cent from 4 per cent in the district banks in Philadelphia and San Francisco.

△ The AISI reports that hot rolled steel product capacity is now 113,785,590 net tons a year, an increase of 10,200,000 net tons over the 1957 capacity.

*June 6*

△ Prices of heavy fuel oil were increased 10¢ per barrel in the Mid-continent.

△ The Commerce Dept. reported that U. S. imports in April, 1960, were approximately $1,200,000,000, down 9 per cent from March, 1960, but an increase of 3 per cent over April, 1959. Commercial exports in April, 1960, rose to nearly $1,700,000,000.

△ The AISI reports that the operating rate of the steel industry for the week of June 6 is scheduled at 1,775,000 tons (62.3 per cent of capacity). This compares with 1,726,000 tons one week ago (60.6 per cent capacity) and 2,604,000 tons one year ago. Index of production for the week is 110.5.

*June 7*

△ The Treasury plans to offer a new 4-year note and a new 8-year bond in advance exchange of existing bonds maturing 17 months hence. Holders at 2½ per cent bonds will be offered 3¾ per cent notes.

△ Auto dealers sold 566,650 U. S.-built cars in May, an increase of 1.8 per cent over April, 1960, and 7 per cent over May, 1959.

△ AISI reports that the steel industry's employment of hourly and salaried workers in April, 1960, totaled 625,508 compared with 637,328 in March, 1960, and 620,601 in April, 1959. The payroll for hourly and salaried workers combined for April, 1960, totaled $357,178,867 compared with $398,847,573 in March, 1960, and $385,488,363 in April, 1959. Hourly rate in April was $3.381 against $3.343 in March, 1960, and $3.340 in April, 1959, excluding estimated employee fringe benefits costing 0.45¢ an hour on the average during 1960. Total hourly costs were $3.831 in April, 1960. Average hours per week worked by wage earners in April, 1960, was 36.5, compared with 40.2 in March, 1960, and 40.7 in April, 1959.

△ The Bureau of Mines reported that the production of Pennsylvania anthracite for May, 1960, was 1,236,000 net tons compared with 1,231,000 net tons in April, 1960, and 1,388,000 net tons in May, 1959.

*June 8*

△ The AISI reports that shipments of finished steel products in April, 1960, totaled 6,741,809 net tons, compared with 7,965,881 net tons in March, 1960, and 8,602,526 net tons in April, 1959.

*June 9*

△ The Commerce Dept. latest statistics point to a second-half slowdown in the rate of outlays for new plant and equipment; unless there is a pickup in the rate, expenditures for 1960 may fall a bit short of the $37,000,000,000 target.

△ A fact-finding board set up by President Eisenhower proposed rail wage increases of 5¢ an hr for 600,000 non-operating employees.

*June 10*

△ The Aluminum Assn. reports that shipments of aluminum sheet and plate in April, 1960, totaled 113,031,000 lb compared with 121,226,000 lb in March, 1960. Shipments of aluminum foil in April, 1960, totaled 17,895,732 lb compared with 20,439,068 lb in March, 1960.

△ The Commerce Dept. reported that steel exports totaled 235,000 tons in April, 1960, up 32,000 tons from March, 1960, and up 39,000 tons from April, 1959. Steel imports decreased to 331,000 tons in April, 1960, down 133,000 tons from March, 1960, and 28,000 tons from April, 1959.

△ The AISI reports that production of steel ingots and castings in May, 1960, totaled 8,832,000 net tons, compared with 9,777,857 tons during April, 1960, and 11,600,581 tons in May, 1959.

*June 13*

△ U. S. balance of payments deficit was reduced to a seasonally adjusted rate of $3,000,000,000 in the quarter ended March 31, 1960, and compares with a $3,800,000,000 deficit for the year 1959.

△ Government funds nearing $2,900,000,000 will be expended in road building for the fiscal year starting July 1, an increase of $173,000,000 over the present fiscal year.

△ The Bureau of Mines reports that domestic use of ferrous scrap and pig iron in the United States in 1959, totaled 127,834,707 short tons compared with 113,622,271 tons in 1958. Of this 66,061,516 tons was scrap.

△ The AISI reports that the operating rate of the steel industry for the week of June 13 is scheduled at 1,775,000 tons (62.3 per cent of capacity). This compares with 1,756,000 tons one week ago (61.6 per cent capacity) and 2,620,000 tons one year ago. Index of production for the week is 110.5.

△ The Bureau of the Census reports that shipments of nonferrous castings in March, 1960, totaled 212,837,000 lb compared with 210,124,000 lb in February, 1960.

*June 14*

Δ The Labor Dept. reported that employment in May, 1960, rose to 67,200,000, up 1,000,000 from April, 1960. Unemployment in May, 1960, dropped to 3,500,000, down 200,000 from April, 1960, but 70,000 above May, 1959.

Δ The Bureau of the Census reports that production of titanium mill products in April, 1960, totaled 534,742 lb compared with 645,276 lb in March, 1960, and 795,222 lb in April, 1959.

*June 16*

Δ Pittsburgh Steamship Co., ore carrying division of United States Steel Corp., announced it will reduce its Great Lakes fleet to 40 from 53 vessels effective June 18, 1960, due to lowered steel requirements.

Δ The Bureau of the Census reports that shipments of commercial steel forgings in April, 1960, totaled 116,717 short tons compared with 137,906 tons in March, 1960, and 135,683 tons in April, 1959.

*June 17*

Δ Scrap copper prices advance ¼¢ to 24½¢ to custom smelters.

Δ The Commerce Dept. reported that personal income in May, 1960, increased to a rate of $399,400,000,000, an increase of $1,600,000,000 over the April rate.

Δ The ARCI reports that deliveries of new freight cars in May, 1960, totaled 5,931 compared with 5,579 in April, 1960, and 3,358 in May, 1959. Orders in May, 1960, amounted to 2,234 compared to 5,551 for April, 1960, and 5,203 in May, 1959. Backlog of cars on order as of June 1, 1960, totaled 36,106, compared with 41,003 on May 1, 1960, and 36,869 on June 1, 1959.

*June 20*

Δ The Japan Iron & Steel Federation reports that production of pig iron in Japan in April, 1960, amounted to 1,038,000 net tons, production of crude steel totaled 1,928,000 net tons.

Δ The AISI reports that the operating rate of the steel industry for the week of June 21 is scheduled at 1,739,000 tons (61.0 per cent of capacity). This compares with 1,775,000 tons one week ago (62.3 per cent capacity) and 2,486,000 tons one year ago. Index of production for the week is 108.3.

*June 21*

Δ The Aluminum Assn. reports that primary aluminum production in the U. S. in May, 1960, amounted to 175,863 short tons compared with 168,596 tons in April, 1960, and 163,857 tons in May, 1959.

Δ Resistance Welder Mfrs. Assn. reports that shipments of resistance welding equipment in May, 1960, were over $2,000,000, backlog of orders as of May 31, remain at more than $11,500,000.

Δ The Bureau of the Census reports that net shipments of aluminum mill products in April, 1960, amounted to 248,809,000 lb, compared wlth 267,149,000 lb in March, 1960, and 294,836,000 lb in April, 1959. Net shipments of aluminum pig and ingot in April, 1960, totaled 119,545,000 lb, compared with 165,921,000 lb in March, 1960, and 128,471,000 lb in April, 1959. Shipments of magnesium mill products in April, 1960, totaled 1,790,000 lb, compared with 1,966,000 lb in March, 1960, and 2,089,000 lb in April, 1959.

*June 22*

Δ The Bureau of Mines reports that consumption of scrap in the United States in April, 1960, totaled 5,627,000 tons compared with 6,655,569 tons in March, 1960. Consumption of pig iron in April, 1960, totaled 5,855,000 tons compared with 6,869,866 tons in March, 1960. Consumer's stocks on hand were 8,277,000 tons scrap and 2,920,000 tons pig iron.

Δ Harvey Aluminum (Inc.), Torrance, Calif., shares of A common stock are being offered to the public at $22.75 per share. This is the first time securities of Harvey Aluminum has been made available to the public.

*June 24*

Δ The Committee on Galvanized Steel Sheet Research, AISI, report that shipments of galvanized steel sheets in the first quarter of 1960 totaled 942,096 net tons, compared with 872,842 tons shipped in this period in 1959.

Δ Britain's pound sterling advanced sharply in the world's chief foreign exchange centers following an increase in the Bank of England's discount rate from 5 per cent to 6 per cent.

Δ The AISC reports that shipments of fabricated steel products in May, 1960, totaled 284,579 tons compared with 286,884 tons in April, 1960, and 294,127 tons in May, 1959. Bookings in May, 1960, amounted to 269,941 tons compared with 344,944 tons in April, 1960, and 241,612 tons in May, 1959. Backlog on order as of May 31, 1960, amounted to 2,237,357 tons.

*June 27*

Δ The F. W. Dodge Corp. reports that construction contracts in the United States in May, 1960, amounted to $3,336,723,000 which was 6 per cent below May, 1959.

Δ National Machine Tool Builders Assn. reports that net new orders of metal-cutting and metal-forming type machine tools in May, 1960, totaled $49,800,000; shipments in May, 1960, totaled $54,500,000.

Δ The Census Bureau reported that private housing starts in May, 1960, amounted to a seasonally adjusted annual rate of 1,305,000 units, unchanged from April, 1960. The actual number of dwelling units started in May, 1960, was 125,700, compared with 123,000 in April, 1960, and 152,500 in May, 1959.

Δ The AISI reports that the operating rate of the steel industry for the week of June 27 is scheduled at 1,560,000 tons (54.8 per cent of capacity). This compares with 1,739,000 tons one week ago (61.0 per cent capacity) and 2,215,000 tons one year ago. Index of production for the week is 97.1.

*June 28*

Δ John Moxon, president, Carpenter Steel Co., forecasts that earnings of the company for the fiscal year ending June 30,1960, will be about $3.50 a share, compared to approximately $2.33 a share in fiscal 1959.

*June 29*

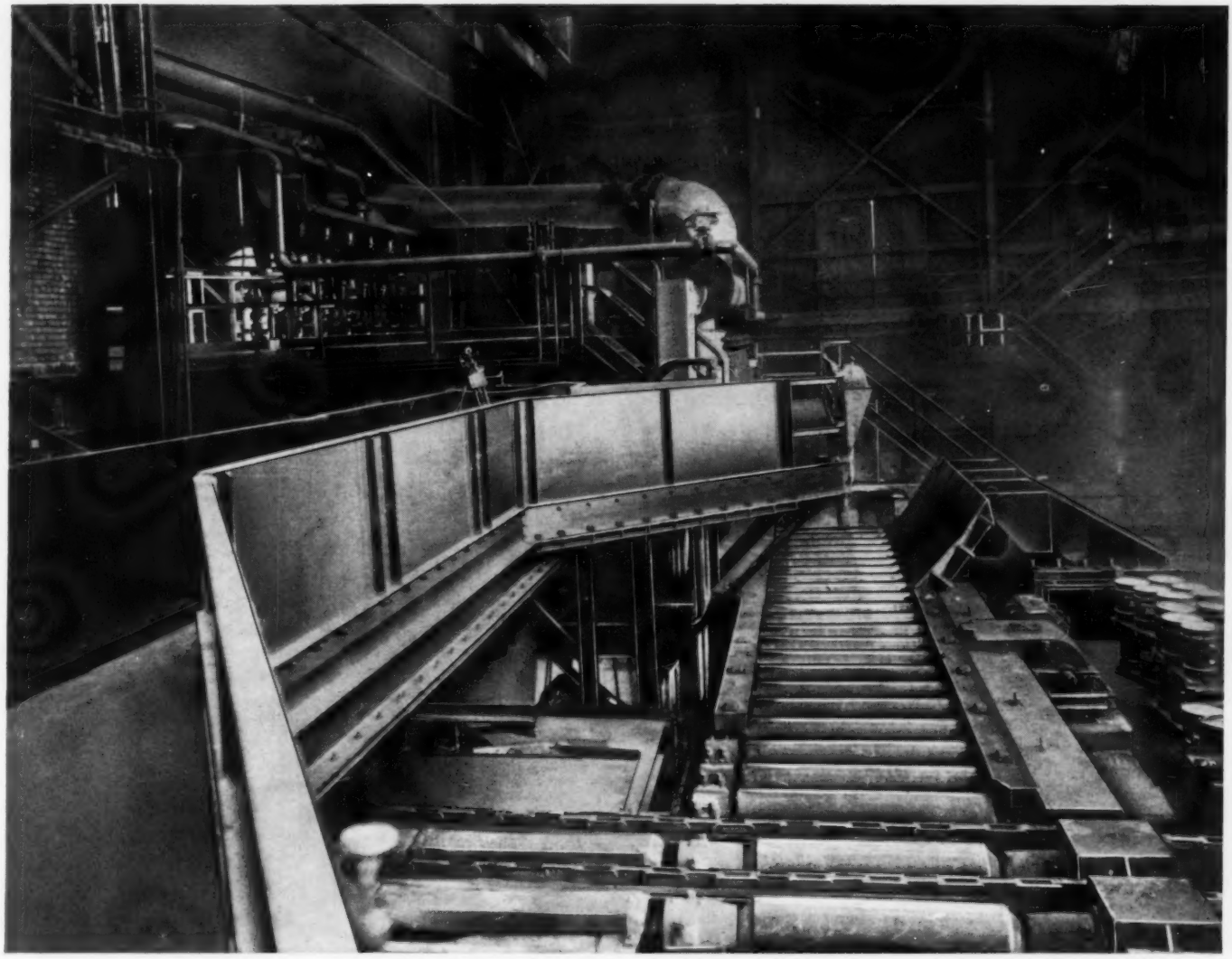
Δ The U. S. Government will show a surplus for the fiscal year ending June 30, well over $500,000,000 comfortably over the $200,000,000 surplus projected in January, 1960.

*June 30*

Δ The Aluminum Assn. reports that net shipments of aluminum sheet and plate in May, 1960, totaled 122,789,000 lb compared with 113,046,000 lb in April, 1960. Shipments of aluminum foil in May, 1960, totaled 18,414,061 lb compared with 17,895,732 lb in April.

Δ McKay Machine Co. announced plans to acquire Federal Machine & Welder Co., Warren, Ohio; offering McKay common stock for Federal common at the ratio of 1 for 19 to Federal stockholders.

Δ USW reported that 480,000 of its 1,250,000 members will be unemployed or working short-time by the end of the week; predicting also that steel industry's operating rate will fall to 48 per cent of capacity next week.



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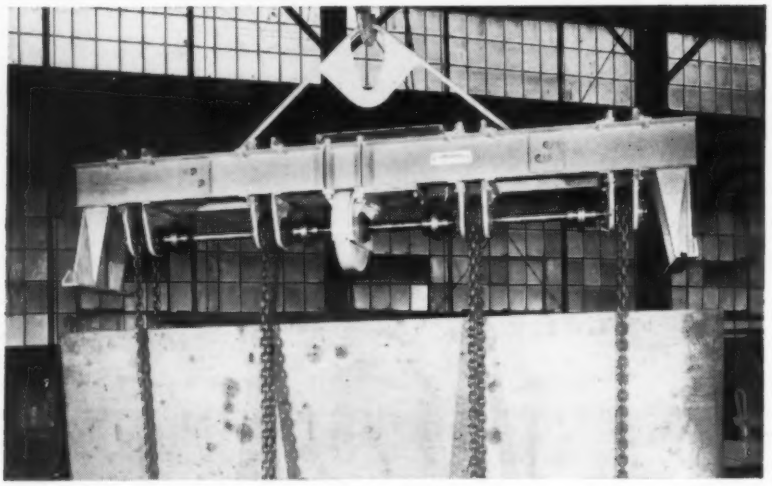
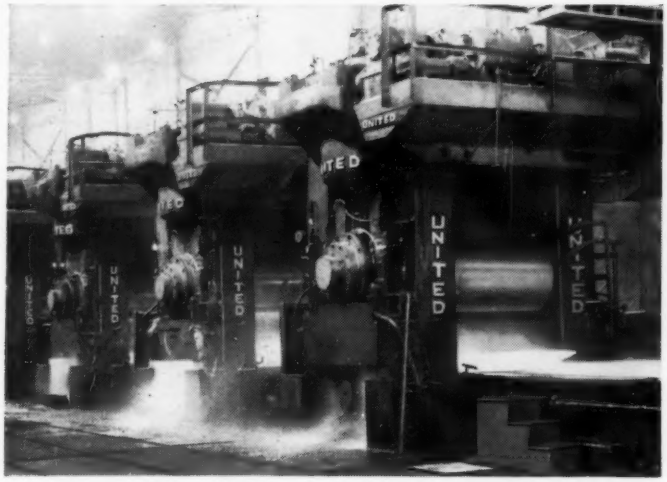
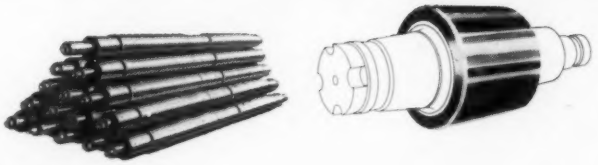


**Handles it:** "If it hangs from a crane, Heppenstall can handle it." Stock tongs are ready for immediate delivery; custom designs are made for special requirements.

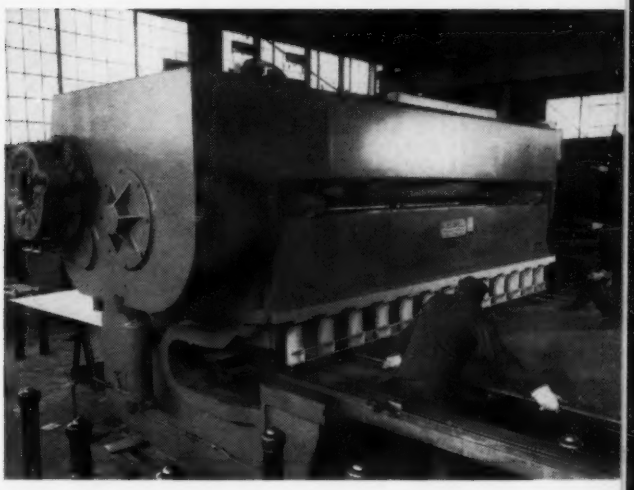
# rolls it...



**Rolls it:** Heppenstall and Midvale-Heppenstall Rolls and Sleeves are made from highest quality alloy steel, thoroughly worked under modern hydraulic presses to obtain maximum density and grain refinement.

# cuts it...



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PAYOFF REEL

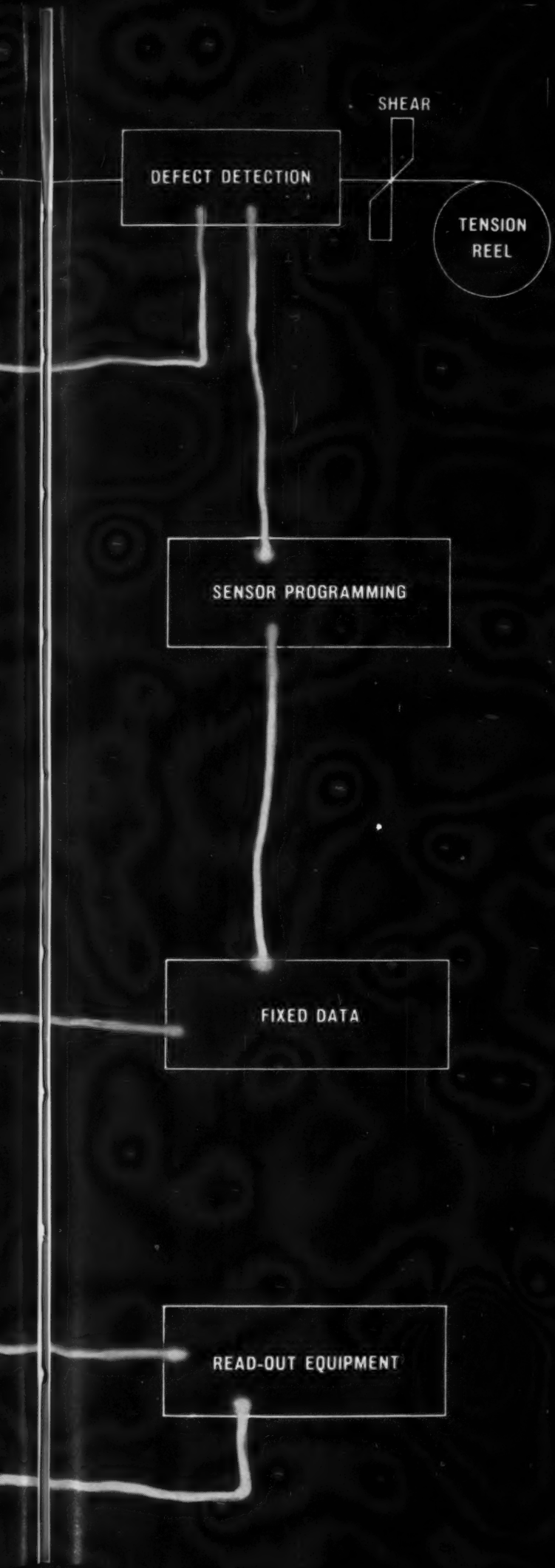
PROCESS FUNCTIONS

PRODUCTION DATA INPUT

POSITION REFERENCE CO-ORDINATOR

IN-LINE AND OFF-LINE AUTOMATIC MONITORING AND CHECKING EQUIPMENT

READ-OUT SCANNING EQUIPMENT




# NEW!

# PRODAC DATA ACCUMULATOR IS VITAL LINK IN OPTIMIZING STEEL MILL PRODUCTION . . .

*Another Step in Westinghouse Progressive Automation*

A large eastern steel mill has found that the completely static-design Prodac* Data Accumulator is providing continuous information and read-out of the product quality of its tin mill products. This installation is providing the basic detailed data that is a prime requisite to the ultimate automatic processing line.

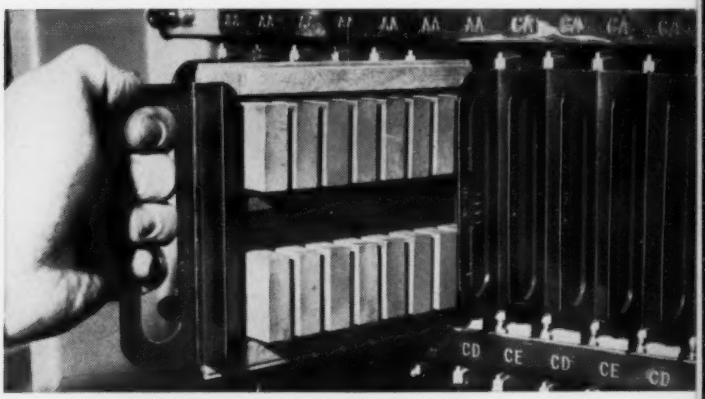
Prodac Data Accumulator Systems provide a complete record of the *product itself*. This record is a natural step in *Progressive Automation* of processing lines, rolling mills and other steel-making operations. The Data Accumulator is fully compatible with most sensing devices, electrical controls and read-out equipment.

For counsel-in-depth on steel mill drive systems application, call your Westinghouse sales engineer. He'll show you how you can economically apply step-by-step *Progressive Automation* to boost product quality, cut costs in your plant. For more information about Prodac, call Westinghouse or write: Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa. J-96147

YOU CAN BE SURE...IF IT'S

**Westinghouse**

TUNE IN WESTINGHOUSE-CBS TV-RADIO COVERAGE, PRESIDENTIAL CONVENTIONS, JULY 10-29




This withdrawn module represents a circuit function. It is easily accessible for removal or replacement.

*Trade-Mark

# Ohio Rolls

SHAPING METAL FOR ALL INDUSTRY

## *Ohio Iron and Steel Rolls*

- FORGED AND HARDENED STEEL ROLLS
- Carbon Steel Rolls
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- Ohioloy "K" Rolls
- Flintuff Rolls
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- Chilled Iron Rolls
- Denso Iron Rolls
- Nickel Grain Rolls
- Special Iron Rolls
- Nioloy Rolls

OR36

**THE OHIO STEEL FOUNDRY CO., LIMA, OHIO**

PLANTS AT LIMA AND SPRINGFIELD, OHIO... *Virtually at the center of the steel industry*

# Industry News...

## U. S. STEEL'S COLUMBIA-GENEVA DIVISION BEGINS CONSTRUCTION OF NEW ORE FACILITY

△ U. S. Steel Corp.'s Columbia-Geneva Steel Division has begun construction of an iron ore mining and beneficiation facility in Fremont County, Wyo., some 26 miles south of Lander.

After completion late in 1962, the extensive ore mining, concentrating and pelletizing operations will supply pelletized iron ore to Columbia-Geneva's Geneva Works. The ore will supplement Geneva's present source of iron ore from mines near Cedar City, Utah, which will continue in operation.

Known as the "Atlantic City Project," the location is 8300 ft above sea level in Wyoming's rugged Wind River Mountains. It is destined to become the highest, large-scale open pit iron mining operation in the United States.

Besides open pit mining operations, major units slated for construction include crushing and screening facilities, an ore concentrating plant, a pelletizing plant, an extensive water storage and handling system and loading and shipping facilities. General and mine office buildings, maintenance shops, warehouse and testing laboratory will also be built.

After operations begin, conventional open pit methods will be used to mine the ore which contains about 30 per cent iron. Next, the ore will be crushed, then conveyed to the concentrating plant where it will be magnetically concentrated to more than 60 per cent iron.

Pelletized ore will be shipped from Atlantic City via the new railroad spur to the Union Pacific line at Winton Junction which serves the coal mining district just north of Rock Springs, Wyo.

A key feature of the operations will be a tailings basin, for settling out waste materials to recover clear water.

To handle the Atlantic City pellets, some modifications or additions will be made to the iron ore storage and conveying facilities at Geneva Works.

## REPUBLIC PLANT BEGINS IMPROVEMENT PROGRAM

△ An immediate start on a $26,000,000 plant improvement program at the Cleveland District plant of the Republic Steel Corp. was announced by Republic president, T. F. Patton.

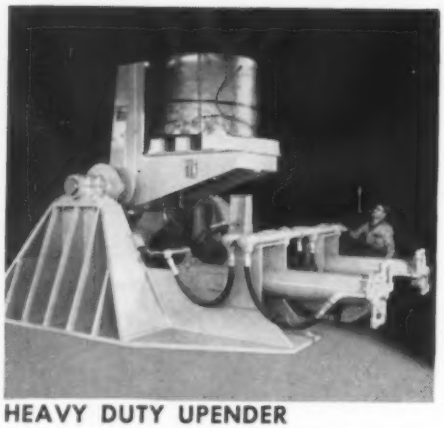
The first two projects to be completed in the plant improvement program will be the modernization of the plant's benzol refining facilities at an estimated cost of $8,950,000, and the replacement of coal preparation facilities at the #1 coke plant at an estimated cost of $4,100,000.

Preliminary engineering work is also underway on an $11,600,000 modernization of the plant's 10-in. bar mill.

Final phase of the program will be a $1,200,000 improvement of material handling facilities to the plant's No. 2 open hearth shop through the installation of elevated tracks and conveyors.

## NEW OXYGEN CONVERTER OPERATING AT McLOUTH

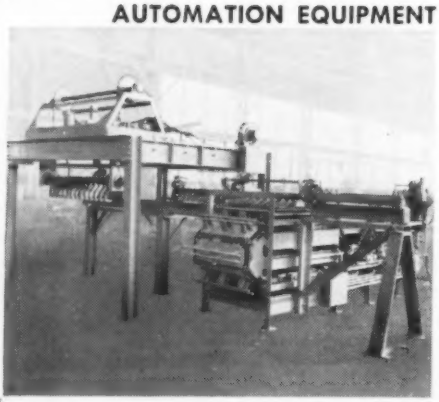
**Built by Pennsylvania Engineering Corp., this latest oxygen converter has gone into production at McLouth Steel Corp. The 110-ton capacity unit supplements production of five other oxygen converters at McLouth—two of 110 tons capacity and three of 60 tons capacity. Pennsylvania Engineering also built the smoke hood and the post crane for handling the hood, oxygen lance and other auxiliary equipment in the McLouth installation. Rather than channeling smoke upward as is the custom, this smoke hood was designed to direct it at right angles into a spark box, then down into the floor from where it is fed into the stack. Overhead clearance limitations made this construction desirable.**



HEAVY DUTY UPENDER

LOG & CHIP HANDLING SYSTEM

AUTOMATION EQUIPMENT



# PV

## FINDS THE ANSWERS

"PV" stands for *Planet Versatility* . . . a quality that has made Planet Corporation known throughout industry as an organization that has solutions to the most perplexing production, materials handling, or automation problems.

Planet Corporation engineers apply uninhibited thinking to problems to find workable solutions that increase efficiency. No job is too big or too difficult . . . Planet's "PV" engineers have automated production lines, built bulk and unit materials handling systems, designed complete foundries, developed the world's only true universal transfer device . . . they are experts, in fact, on all types of special handling and automation machinery, and materials handling equipment.

Let Planet demonstrate how its versatile engineering skill, and production and erection know-how can help you. Discuss your problem with a Planet "PV" engineer . . . *it pays to Plan with Planet.*

PLANET CORPORATION

98

ENGINEERED HANDLING SYSTEMS
• AUTOMATION EQUIPMENT
• MILL & FOUNDRY HANDLING EQUIPMENT

1816 SUNSET AVENUE • LANSING, MICHIGAN

### SWEDISH PLATE MILL GOES INTO PRODUCTION

△ Schloemann Aktiengesellschaft, has built for Oxelösunds Järnverks AB, Oxelösund, Sweden, a plate mill complete with auxiliary equipment. The plant, which is laid out for a monthly production of 30,000 to 35,000 metric tons of plate, was recently put into operation.

The four-high reversing mill has a barrel length of 12 ft. The finishing line consists of a hot leveler, two cooling beds with plate turnover and a shear line having four rocking shears, in addition to piling and mechanical handling equipment.

### POLLOCK WILL BUILD J&L TRANSFER CARS

△ The William B. Pollock Co. has been awarded a contract by Koppers Co., Inc., to furnish five self-propelled steel ladle and slag pot transfer cars. The cars are a part of the Jones & Laughlin Steel Corp.'s oxygen steel plant expansion at Cleveland, Ohio.

The ladle transfer cars are designed to handle 200-ton heats from the new oxygen vessels. The slag cars will handle two pots of 500 cu ft capacity each.

### W. W. CLARK AWARDED THREE MILL CONTRACTS

△ Electrical construction contracts totaling several million dollars for three major steel companies are announced by The W. W. Clark Corp.

For the Crucible Steel Co. of America, the firm is scheduled to complete a modernization program of the hot mill facilities in the Midland, Pa., plant by December 1. When completed, this program will greatly increase the productive capacity and improve quality facilities for Crucible's stainless steel and other special steels.

The second contract covers all electrical construction work in the installation of a new electrostatic dust-collection system and new waste-heat boilers in the open hearth and oxygen steelmaking section of the Cleveland Works of Jones & Laughlin Steel Corp. In addition to the installation work, the Clark organization will handle all of the

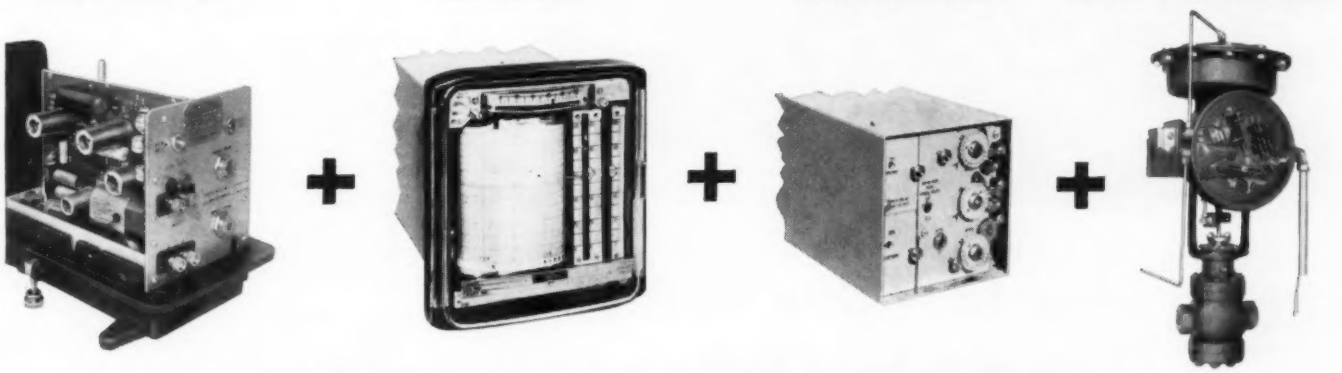
# *Taylor* IS TODAY'S BIG NAME IN ELECTRONIC PROCESS CONTROL

The name 'Taylor' has long been famous for pneumatic control. This reputation was recently enhanced by the introduction of the highly successful TRANSCOPE* pneumatic line.

Now, one year since their announcement, TRANSCOPE Electronic instruments have already established new standards of convenience and accuracy.

Paralleling all the outstanding features of the TRANSCOPE pneumatic line, these electronic instruments have proven their dependability in field service. They are "naturals" for the metals industry. Why not call in your Taylor Field Engineer to consult with you, or write for **Catalog 98335.** Taylor Instrument Companies, Rochester, N.Y., and Toronto, Ont.

**TRANSMITTER** + **RECORDER** + **CONTROLLER** + **VALVE POSITIONER**



## = ELECTRONIC PROCESS CONTROL

**700T Potentiometer Transmitter** is famous for high accuracy and dependability. Senses and converts Temperature (either thermocouple or resistance elements), Load, Speed, pH or other millivolt signals to an electrical and/or pneumatic output. Electronic balancing. No need for slide wires, batteries, cells or moving parts. Interchangeable plug-in service cans permit quick adaption for use with different primary elements.

**701J AC or DC Recorder** is all transistorized, unaffected by ±10% line voltage variation. Positive, precise pen positioning assured by extremely powerful servo-motor. Control settings can be made from front or rear of case. Plug-in Recorder slide can be removed without disturbing process control.
Other plug-in features include set point transmitter, automatic-to-manual switching unit and controller mechanism.

**704R AC or DC Controller** has all benefits of most advanced control circuits. Unique diode limiter circuit permits even two-response controllers to eliminate over-peaking on most applications. Effective at all times whether variable is approaching control point from above or below; on changes in set-point; following major process disturbances, or on start-up.
Unaffected by line voltage changes up to ±10%.

**713R Valve Positioner** couples advanced electronic control with smooth pneumatic action. Converts an electrical milliampere input from the controller into a pneumatic force, insuring positive positioning of valve actuator proportional to electrical input. Unmatched stability, due to a powerful, balanced armature that minimizes effects of shock and vibration. Designed for Class 1, Group D, Division 1 equipment.

*Reg. U.S. Pat. Off.

*Taylor Instruments* **MEAN ACCURACY FIRST**

electrical engineering, including a large variety of switchgear, transformers and other key electrical apparatus. The Cleveland firm also will install all of the electrical equipment for a new five-stand tandem cold mill and a two-stand temper pass mill in the new plant of the Midwest Division of the National Steel Corp.

## GROUND BROKEN FOR NEW SINTER FACILITIES

△ Ground has been broken for new breaking, screening and cooling facilities for the sinter plant at the New York Ore Division of Jones & Laughlin Steel Corp.

The new facilities, which are being installed by Dravo Corp., include a vertical shaft stationary cooler—the first of this type to be installed in the United States. Capacity of the new unit will be 3800 gross tons of product per day.

The breaker, cooler and auxiliary equipment will serve two six-foot-wide sinter machines now in use.

The cooler will utilize air to lower the temperature of the hot sinter sufficiently to permit its loading directly into railroad cars. Normally, sinter is cooled to approximately 200 F for convenient handling on rubber conveyor belts.

As the fused sinter leaves the two machines, it will be discharged onto an apron feeder, which will carry it to a single Dravo-Lurgi breaker. The material then will pass across a Dravo-Schenck vibrating screen to remove hot fines. A pan conveyor will then deliver the screened sinter to the cooler. At the discharge end of the cooler, a combination feeder-screen will remove cold fines and deliver cooled sinter to railroad cars.

This is Dravo's third contract with Jones & Laughlin for sinter equipment. A circular cooler was installed at J&L's Cleveland, Ohio, sinter plant, and a complete plant with a single 13-ft, 2-in.-wide strand

day in – day out
DEPENDABILITY

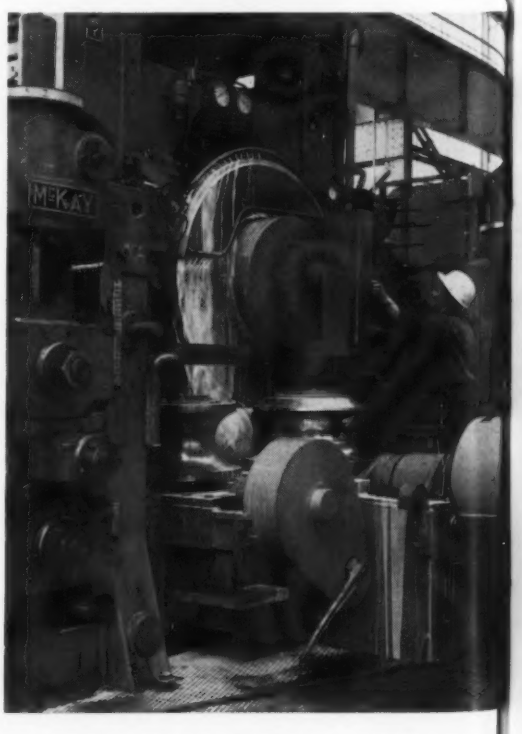
Atlas cars like the 75-ton ore transfers above are built to the individual load and schedule of each user. This custom engineering method, with matching care in manufacturing, assures dependable service incorporating all approved personnel safety features.

*Since 1896 designers and builders of Ore Transfers . . . Scale Cars . . . Coke Quenchers . . . Coal Larries . . . Door Machines . . . Safety-Type Transfers . . . Storage Battery Locomotives*

**ATLAS CAR & MFG. COMPANY**
1140 IVANHOE ROAD
CLEVELAND 10, OHIO


## PIPE MILL

**Illustration shows a portion of the 16 in. pipe mill which was built by The McKay Machine Co. for Phoenix-Rheinrohr, A.G. of Duesseldorf, West Germany. Pictured is the welder—the 160,000 amp McKay rotary oil-cooled electric resistance weld unit. The unit features load cells to measure the pressure of the electrode and forging rolls on the tube and motorization of all principal adjustments. The electrical ratings on this unit include a 1750 kva generator and an operation on 116.6 cycles. The transformer has an output rating of 1200 kva, and its primary as well as the generator is rated for 2400 volt operation.**



$O_2$

AMERICAN MESSER

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Messer

. . . . . for air separation plants designed for steel mill applications, think *first* of American Messer.

AMERICAN MESSER CORPORATION
Chrysler Building, 405 Lexington Ave.
New York 17, N.Y.

is under construction at the Aliquippa, Pa., works.

## DEEP-SHAFT COAL MINE DEDICATED IN ILLINOIS

△ A major deep-shaft coal mine was officially dedicated near Benton, Ill., last month.

Owned and operated by the Old Ben Coal Corp., the mine, No. 21, taps a reserve of 100,000,000 recoverable tons of low-sulphur coking coal, 670 ft below the surface.

The coal is expected to meet the growing needs of the Midwest's expanding steel industry, as well as the needs of utilities, factories and domestic users.

By 1962, production at Mine No. 21 is anticipated to be 3,000,000 tons a year, making it one of the largest bituminous coal mines in the United States.

Designed for continuous mining and processing of coal, the mine makes maximum use of automated equipment. From the time the coal is bored from the seam until it tumbles into waiting rail cars and trucks, it is handled almost completely automatically.

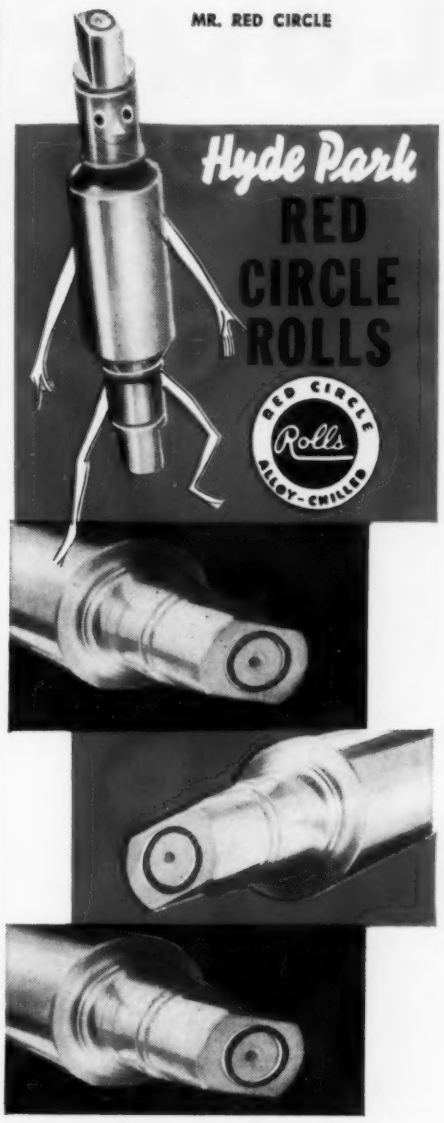
By the end of next year, Mine No. 21 is expected to be operating at its top capacity of 15,000 tons daily. At this rate, the mine's reserve is expected to last between 30 and 40 years. The 100,000,000 tons of recoverable coal in the mine is the largest commercially available tonnage of low-sulphur metallurgical coal remaining in Illinois.

The reserve was purchased in 1918. Development began with the sinking of the first shaft in April, 1956. The first coal was hoisted on January 4, 1960.

## PRODAC CONTROL SLATED FOR GARY PLATE MILL

△ "Prodac" computer-programmed control from the Westinghouse Electric Corp. will make U. S. Steel Corp.'s plate mill in Gary, Ind., one of the world's most fully automatic. In addition, Westinghouse will supply a 10,000-kw Ignitron converter-inverter power system, 400 cps Magamp regulators and main drives and auxiliary equipment totaling about 36,000 hp. Ventilation equipment for the 242,500 cfm recirculation air system includes air cleaners, fans and heat exchangers.

MR. RED CIRCLE




A Roll for Every Purpose

Our engineers will be glad to work with you in the production of any special rolls or rolling mill equipment.

**Iron Base Type Rolls**
**Nickel Alloy Grain Rolls**
**Nickel Chilled Rolls**
**Grain Rolls**
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**Moly Rolls**
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Hyde Park
FOUNDRY AND MACHINE CO.
HYDE PARK
Westmoreland County, Penna.

Rolls
Rolling Mill Equipment
Gray Iron Castings

# LOMA

## TUBE COILERS AND WINDERS

**FOR THE PRODUCTION OF**

- SINGLE-LAYER COILS
- DOUBLE-LAYER COILS
- BUNCH-TYPE COILS
- LEVEL-WOUND COILS

LOMA Tube Coilers and Winders handle ferrous and non-ferrous tubing at high speeds in a wide range of tube sizes, coil shapes and coil dimensions to suit any shipping and packaging requirements. The equipment is available either as individual units or combined with drawing, straightening and cut-off machines arranged for completely synchronized operation.

LOMA Tube Coilers are designed with maximum flexibility and can produce single and double-layer pancake as well as bunch-type coils in sizes of ⅛" to 1⅝" O.D.

LOMA Tube Winders are designed to produce perfectly level-wound packages of ⅛" to ¾" O.D. tube. Spool cores are mounted on the reel shaft which is traversed in accordance with the lay desired while it winds the tubing at constant tension.

Our standard line of equipment includes:

- Casting Machines and Molds
- Saws and Cut-off Machinery
- Hot and Cold Rolling Mills
- Rod and Tube Draw Benches
- Roller and Stretcher Levellers
- Air and Hydraulic Tube Testers

**LOMA**
**MACHINE MFG. CO., INC.**
114 East 32nd Street
New York 16, N. Y.


The 160/210-in. reversing plate mill will handle slabs ranging from three to 24 in. thick, 48 to 75 in. wide and 54 to 264 in. long. Mild low carbon, medium and high carbon, low and high-alloy steels will be rolled in the mill. Finished plates will range upward from 3/16 in. thick, 198 in. wide and 45 to 125 ft long.

"Prodac" control features a combination of card programming, computing and correction monitoring by means of roll force and x-ray thickness measurements to produce plate within close tolerances of specified thickness, width and length. The punched-card digital input to the computer-programming control will be minimal. The computer will determine the number and sequence of passes, settings of screwdowns, guides, etc., and will use control feedback information to correct for product dimensional deviations.

Formerly, mills of this type were powered by flywheel or synchronous m-g sets. Now, the converter-inverter Ignitron arrangement, first such application made by Westinghouse, will supply power to the mill drive motors with proper voltage polarities needed for reversing service and will permit regeneration of power.

### NIPPON KOKAN ADDS HEAT TREATING LINE

△ Adding to the existing heat-treating facilities installed in 1959, construction has been started at the plant of Nippon Kokan K.K. in Tokyo, Japan, to complete a continuous wide plate heat-treating line. Designed by Drever Co., the new equipment to be installed includes pressure quench, tempering furnace and related conveyor tables.

In combination with the previously installed charging table, hardening furnace and discharge table, the line will continuously normalize and temper widths up to 126 in. by 45 ft 0 in. long and up to 2⅜ in. thick. Heavier plate in narrower widths will also be handled.

Startup of the line is expected in early 1961.

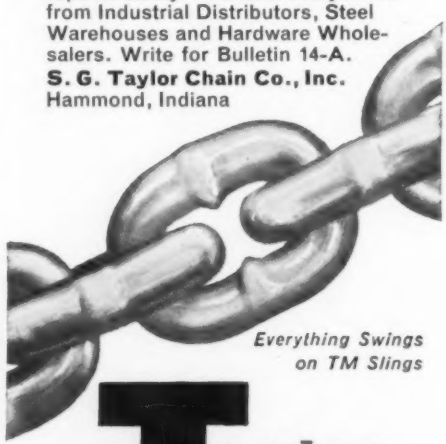

**USE THE ENGINEERING MART**



# TOPS in SAFETY

TM Alloy Chain puts muscle in your safety record. A minimum breaking strain of approximately 125,000 lbs. psi . . . rugged stress-free links . . . controlled heat-treating, are a few reasons why TM Alloy Chain is tops in safety. Available everywhere from Industrial Distributors, Steel Warehouses and Hardware Wholesalers. Write for Bulletin 14-A.

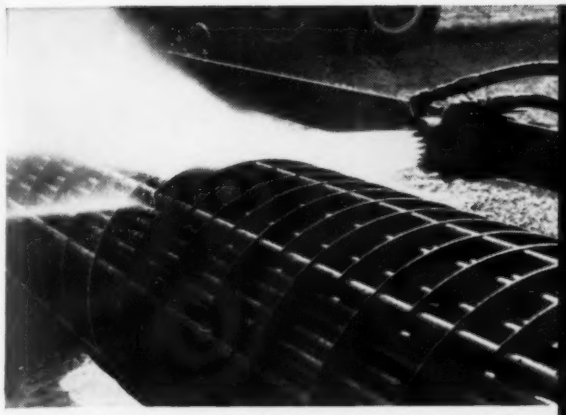
**S. G. Taylor Chain Co., Inc.**
Hammond, Indiana



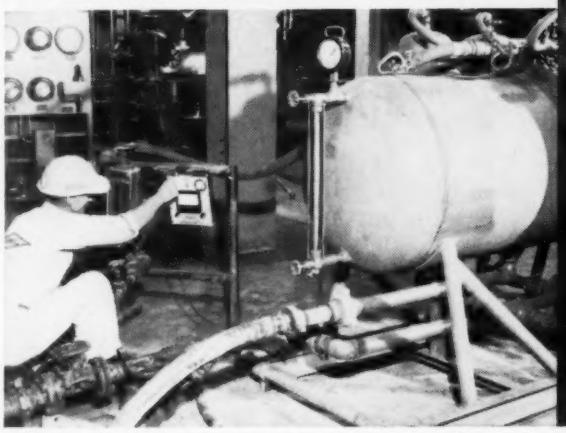
*Everything Swings on TM Slings*

**Taylor Made CHAIN** SINCE 1873

## *A new mark for a nation-wide cleaning service . . .* DOW



Jetting tool cleans tubes fouled with coke and asphalt.



New mobile foam-cleaning equipment cuts cleaning costs.

Cleaning missile lines and components requires tolerances as close as 150 microns.

# DOW INDUSTRIAL SERVICE

**Industrial Cleaning.** Dow Industrial Service, now a separate division of The Dow Chemical Company, offers the only nation-wide chemical cleaning service for virtually all types of industrial processing equipment. This is an expansion of the cleaning service developed over the past 20 years. Dow is currently servicing entire plants as well as doing special cleaning jobs for both large and small companies.

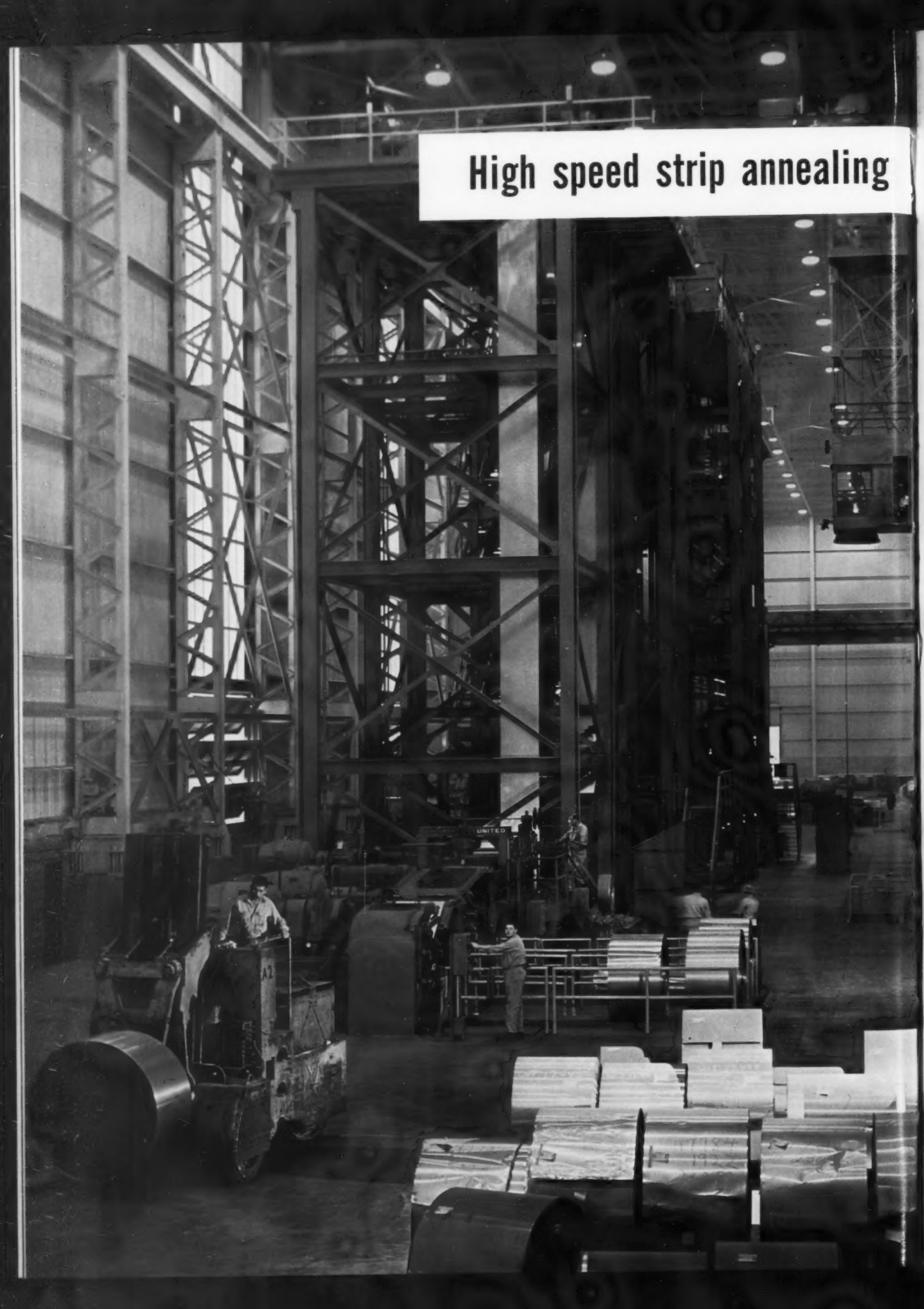
Dow Industrial Service research in industrial chemical cleaning has developed specialized mobile equipment and techniques, some of which are pictured above. These highly efficient techniques are improving plant productivity and reducing equipment downtime in all industries using steam generators, condensers, heat exchangers, towers, water and product lines, water wells and tanks, or similar process equipment.

**Product Sales and Service.** The sale of specialized chemical products, scientifically formulated to be of use in specific industrial processes and to give the necessary technical service in their use, is the job of Product Sales and Service. Purifloc* N17 is an outstanding new flocculant cleared by USPHS for use in potable water.

**Laboratory Service.** Because of the rapid development of chemical products for the municipal and industrial waste and water treatment areas, Dow Industrial Service will take on the service-selling of those products. Also, a consulting laboratory service for municipal and industrial waste and water treatment is provided.

**You'll find Dow Industrial Service offices and stations with specialized cleaning equipment and experienced personnel in all major industrial areas. For more information, write to Dow Industrial Service, 20575 Center Ridge Road, Cleveland 16, Ohio.** *TRADEMARK

**DOW INDUSTRIAL SERVICE** DOW *Division of THE DOW CHEMICAL COMPANY*


High speed strip annealing
giv

# gives steel makers major cost and product benefits

## *Evolution of process gets major assist from Reliance's creative engineering*

Speeds up to 2,000 feet per minute, thinner gauge steel, greater annealing uniformity, and higher tonnage output are the chief reasons for the spread of this process. Actually, lines like this one at Kaiser Steel can handle gauges from .0150″ down to .0070″ in coils up to 90″ outside diameter and widths of 42″ or greater . . . reducing costs in a growing tinplate industry.

Associated electrical equipment must be upgraded to meet the call for higher yield annealing lines. Reliance engineering is presently meeting that challenge. Here are some of the ways:

### Furnace tension control

On advanced Reliance systems, the exit bridle is the lead and overall furnace tension is maintained by the entry bridle. Maximum line flexibility is provided, since the entry bridle can be position-controlled or tension-controlled. In tension-control, a regulator monitors the bridle torque, maintaining it at the present level.

For position-control, a torque-regulated furnace tension unit position-controls the entry bridle. The tension unit consists of a short loop provided by a loaded roll, the position of which modifies the speed of the entry bridle. The roll may be locked in position when the bridle is directly controlling strip tension.

### Helper drive torque regulation

Since it is economically unfeasible to regulate each of many furnace helper motors, the helpers have been grouped by furnace function (heat section, hold section, slow cool and fast cool). Each group is torque-regulated and each motor held within a group can be adjusted manually to take its share of the load while the entire section automatically holds its relative load position with respect to other sections. Reliance has encouraged the use of this system.

Reliance also strongly recommends the equipment explained below:

### Strip-tension measuring load cells

These measure the strip tension existing at the exit end of each furnace section. Associated recording meters enable the operators to relate strip quality and elongation to helper drive torque settings of each section for different conditions of speed, gauge, etc; in other words, able to study various settings of torque—and be able to repeat those which give the best results.

### Automatic furnace tension control

The load cells provide an output signal which *can* be used as an input to the section torque regulators to maintain continuously desired tension. Correct inertia compensation for line speed changes is inherently provided by this system.

### Synchro-control of looping tower

This eliminates inaccessible or hard-to-service photo-electric elements. A synchro is used to indicate and regulate tower position.

### Automated strip feed-up

This increases the efficiency of entry end material handling, allowing high furnace speeds to be maintained.

It will pay you to discuss with Reliance engineers some of the fine points of annealing line system controls and drives. Creative application engineering, plus the ability to assume total responsibility through start-up and service are the reasons why Reliance is so readily acceptable at engineering, production and management levels of industry. Call your Reliance Sales Engineer. He has an office near you. If you prefer, write for Bulletin L-2513.

L-1672

Product of the combined resources of Reliance Electric and Engineering Company and its Master and Reeves Divisions

**RELIANCE** ELECTRIC AND ENGINEERING CO.

DEPT. 117A1 · CLEVELAND 17, OHIO
Canadian Division: Toronto, Ontario
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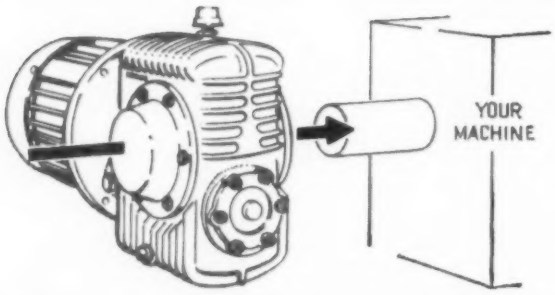
Duty Master A-c. Motors, Master Gearmotors, Reeves Drives, V★S Drives, Super 'T' D-c. Motors, Generators, Controls and Engineered Drive Systems.

# CONE-DRIVE GEARMOTORS for "PLUG-IN" POWER




***Hollow-Shaft Speed Reducer-Motor forms complete power transmission package . . .***

With the compact, right-angle Cone-Drive gearmotor the machine designer can make use of an integral drive package of nearly any required speed and horsepower. Twenty-seven standard output speeds from 7.3 to 525 RPM (with 1750 RPM motor) are available in models from ¼ to 40 horsepower. Gearmotors can be specified with hollow shaft for mounting in any position, ready to "plug-in". You can use this integrated power package to provide a simple, clean installation on your machine . . . no pulleys, belts, sheaves, bed plates, couplings, etc.

Electric motors are standard "D" flange type with slight shaft modification for driving helical primary reduction gears. Secondary reduction stage is a standard Cone-Drive double-enveloping worm gearset with maximum tooth engagement for greater load carrying capacity in smaller space.

Cone-Drive gearmotors are available for all AGMA service ratings. Call your Cone-Drive representative today or write for catalog #58 for complete specifications.

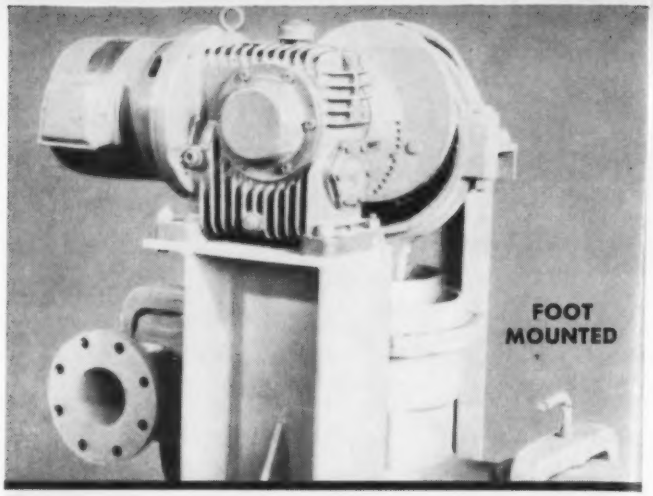
**CONE-DRIVE GEARS**
**DIVISION MICHIGAN TOOL COMPANY**
*7171 E. McNichols Road Detroit 12, Michigan Telephone: TWinbrook 1-3111*

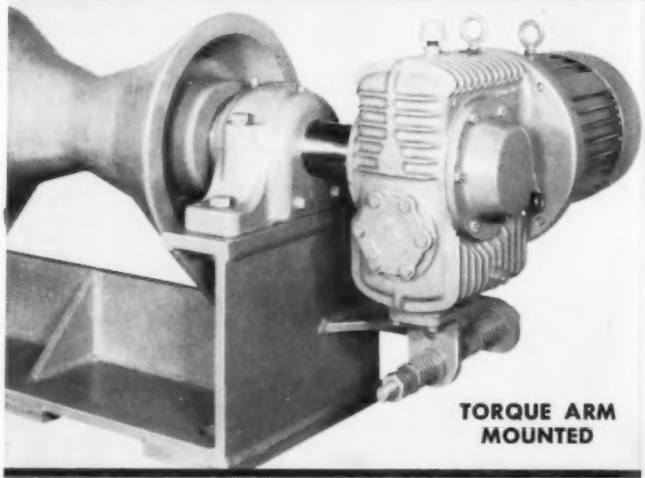
DOUBLE-ENVELOPING WORM GEARSETS

DOUBLE-ENVELOPING WORM GEAR SPEED REDUCERS

DOUBLE REDUCTION WORM GEAR SPEED REDUCERS

DOUBLE-ENVELOPING RIGHT ANGLE GEARMOTORS

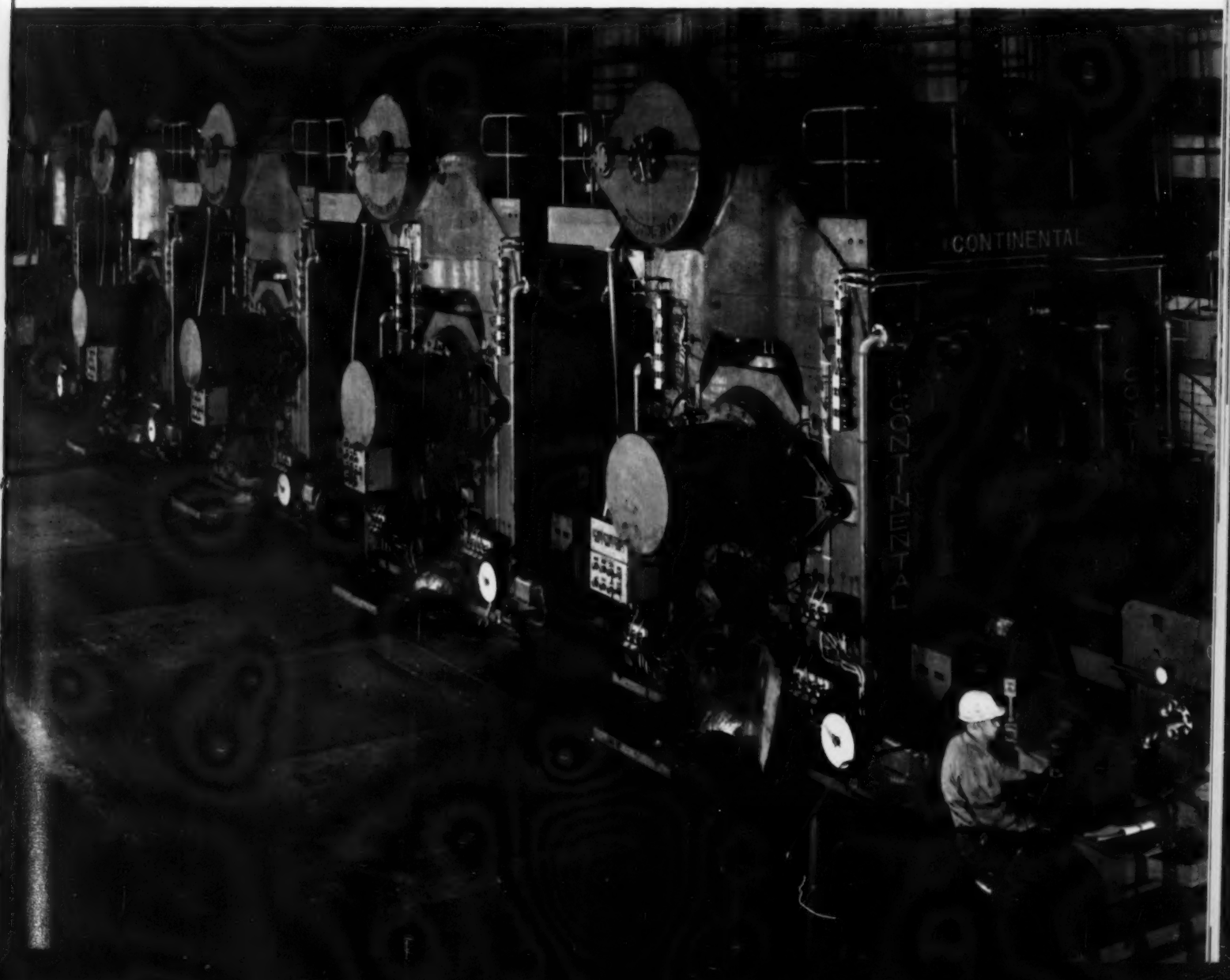


# BLAW-KNOX

Blaw-Knox designs and builds a full range of continuous, semi-continuous and single stand reversing hot strip mills. Other Blaw-Knox equipment for the metals industry includes complete rolling mill installations and auxiliary equipment for ferrous and non-ferrous metals, sheet and strip processing equipment, electrolytic tinning, annealing, and galvanizing lines, seamless pipe and tube mills, draw benches, and cold draw equipment, Blaw-Knox Medart cold finishing equipment, iron, alloy iron and steel rolls, carbon and alloy steel castings, fabricated steel plate or cast-weld design weldments, steel plant equipment, and heat and corrosion resisting alloy castings. Blaw-Knox Company, Foundry and Mill Machinery Division, Blaw-Knox Building, 300 Sixth Ave., Pittsburgh 22, Pa.

56-inch semi-continuous hot strip mill.



# BLAST FURNACE GAS WASHING

***Chemico P-A Venturi washers selected for 36 installations at 20 separate plants...***

In furnaces from coast to coast, the Chemico P-A Venturi washer is proving the single most economical and effective method of cleaning blast furnace gases. Prior to the introduction of the Venturi blast furnace washer, the dust content of the gas from conventional primary washers ranged from 0.15 to 0.35 grains/CF. The Venturi washer can achieve results as low as 0.005 grains/CF.

Low initial cost, inexpensive installation and virtually no maintenance are the more obvious economic advantages of Venturi blast furnace washers. In addition, however, Chemico Venturi washers require very little water—one-third as much as conventional washers—and permit complete recycle.

They are rugged units which have proved their reliability and long life in actual working furnaces. Also important is their ability to handle wide fluctuations in gas volume without sacrificing cleaning efficiency. With 36 units now in operation or on order, you can be certain of proven performance with a Chemico P-A Venturi washer.

If you are considering the installation of gas cleaning equipment in a blast furnace, a Chemico representative would be pleased to show you the kind of top-performance job you can expect from a Venturi washer. And remember, Chemico handles the complete job... PLANNING, DESIGN, ENGINEERING, ERECTION and START-UP.

**CHEMICO**

CHEMICAL CONSTRUCTION CORPORATION
Gas Scrubber Division
525 West 43rd Street,
New York 36, New York

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PORTLAND, ORE.
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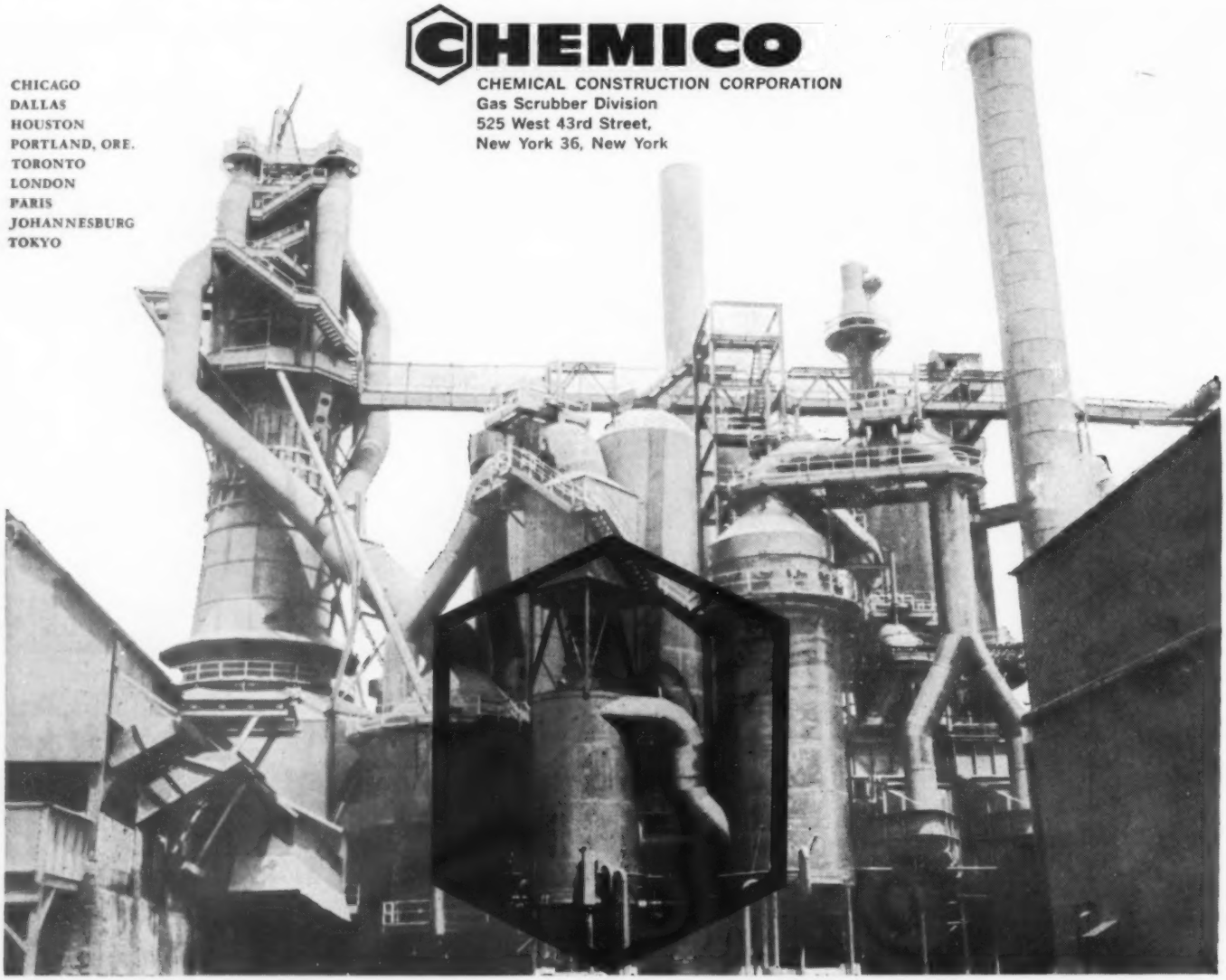
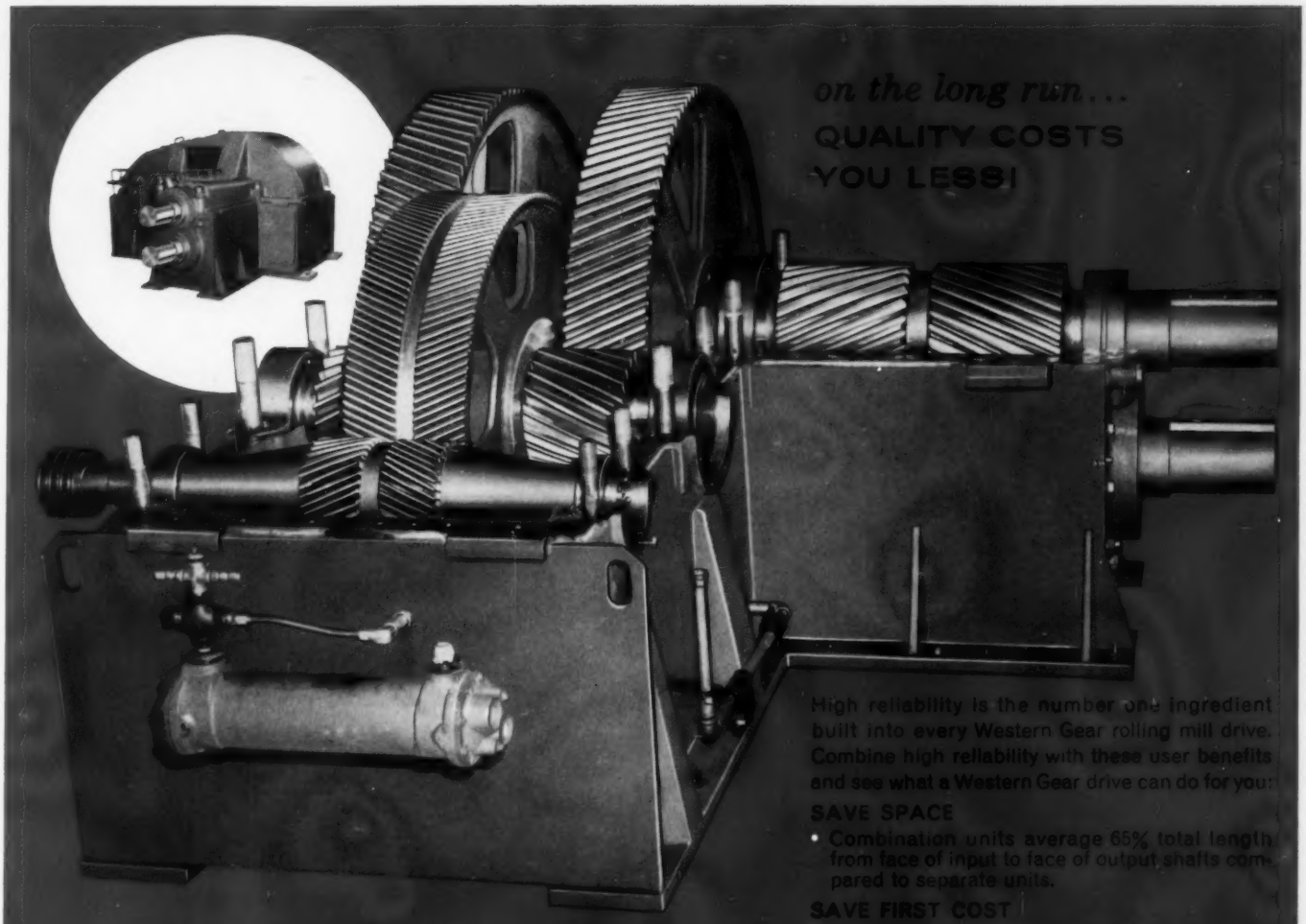




*on the long run...*
QUALITY COSTS YOU LESS!

This 10½ ton integral pinion stand and reducer was designed and manufactured by Western Gear Corporation for Hunter Engineering Co. One of the largest rolling mill drives of its type ever built in the west, it will drive a Hunter 13½" and 34" x 62" 4-high breakdown and semi-finishing mill in the aluminum foil industry. A second similar drive is now under construction for delivery to a foreign customer.

High reliability is the number one ingredient built into every Western Gear rolling mill drive. Combine high reliability with these user benefits and see what a Western Gear drive can do for you:

**SAVE SPACE**
- Combination units average 65% total length from face of input to face of output shafts compared to separate units.

**SAVE FIRST COST**
- Fewer parts
- Less shafting
- One less coupling
- Fewer bearings
- Fewer seals

**SAVE INSTALLATION COST**
- Smaller foundation pad
- No aligning time

**SAVE OPERATING MAINTENANCE**
- Fewer parts to wear
- No alignment problems
- Easy maintenance due to large inspection opening

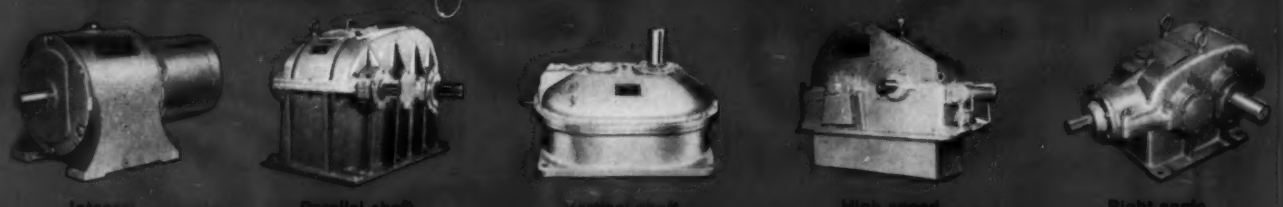
W INDUSTRIAL PRODUCTS DIVISION

WESTERN GEAR CORPORATION

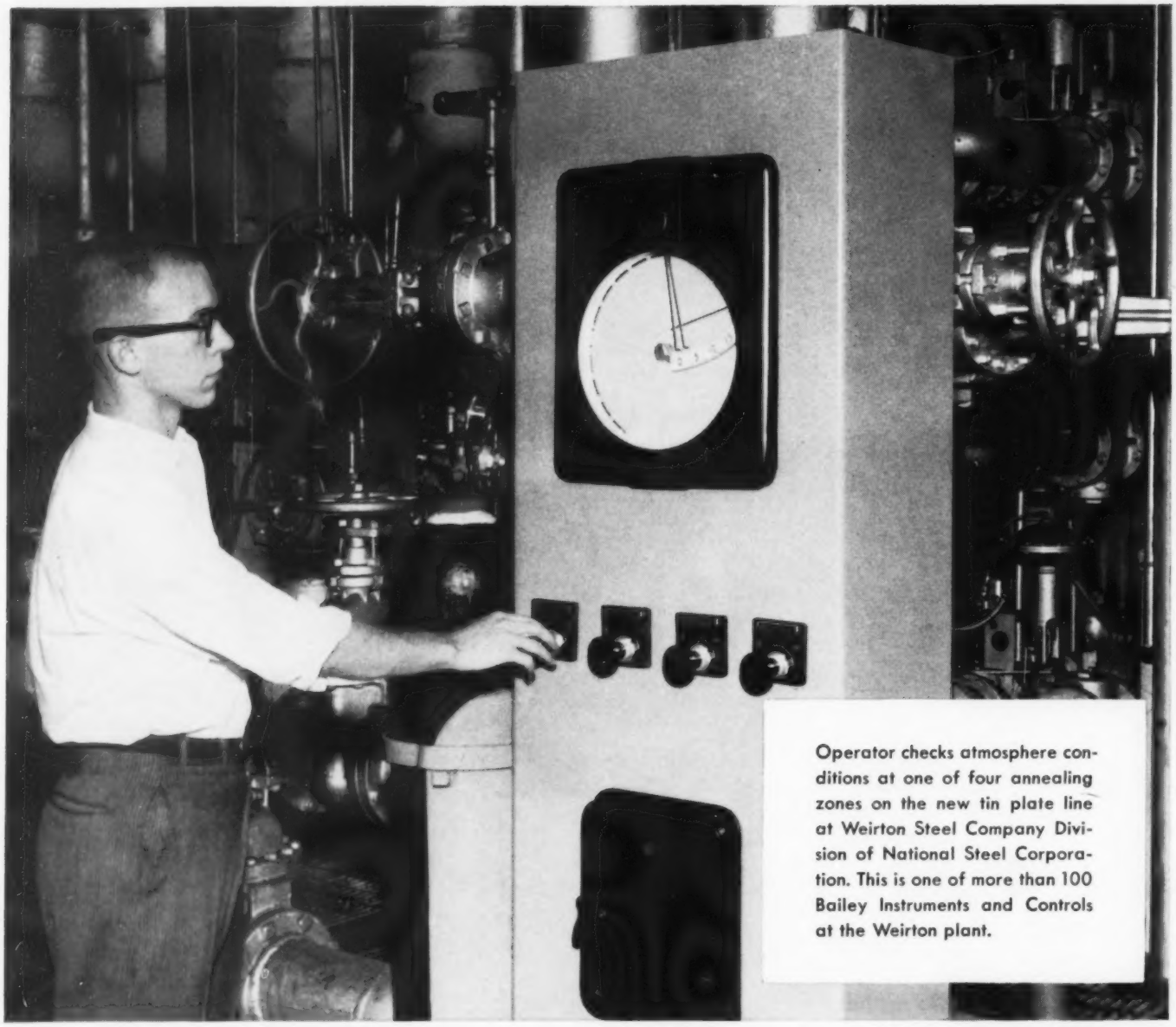
*Contact the Western Gear representative in your city or write, wire or phone:*

**WESTERN GEAR CORPORATION**
Industrial Products Division
P.O. Box 126 · LYtel 3-7611
Belmont, California

OTHER WESTERN GEAR POWER TRANSMISSION PRODUCTS



Integral gearmotors | Parallel shaft reducer | Vertical shaft reducer | High speed unit | Right angle reducer



Operator checks atmosphere conditions at one of four annealing zones on the new tin plate line at Weirton Steel Company Division of National Steel Corporation. This is one of more than 100 Bailey Instruments and Controls at the Weirton plant.

# This Bailey instrument gives you 2 atmosphere checks for the price of 1

You can measure combustibles *and* oxygen with this Bailey Analyzer-Recorder . . . at less than the price of other instruments that make only single measurements.

Only Bailey gives you a continuous recording of *both* oxygen and combustibles on the same chart for quick, simple comparison. You can reduce costly furnace purging time by accurately measuring oxygen instead of guessing. Measuring oxygen also drastically reduces danger of explosion. The Oxygen Analyzer-Recorder can detect small furnace leakage of steel-scaling oxygen—thus assuring higher product quality.

The Bailey instrument is by far the most efficient and economical way of controlling atmospheric conditions in annealing furnaces. See your Bailey Engineer or write to the Iron and Steel Division for complete information.

S113-1

***IRON AND STEEL DIVISION***

## BAILEY METER COMPANY

***1047 IVANHOE ROAD • CLEVELAND 10, OHIO***

**In Canada—Bailey Meter Company Limited, Montreal**

BAILEY METERS

Anneal 430 Trim Stock and All Other Stainless Strip to a Durable, Mirror Finish *Without Chrome Depletion* in

THE ELECTRIC EF FURNACE CO.
GAS • OIL • ELECTRIC

# Continuous *Stainless Strip Bright Annealing* Furnaces

## *Check these outstanding advantages*

✔ **DESIGNED AND BUILT BY THE WORLD'S MOST EXPERIENCED BUILDER OF STAINLESS STRIP BRIGHT ANNEALING FURNACES.** 15 efficient, high production lines installed or under construction. EF has more installed capacity, and more experience in bright annealing stainless strip than any other furnace manufacturer.

✔ **VERTICAL OR HORIZONTAL DESIGNS**—whichever best suits your building conditions and specific production requirements.

✔ **FUEL FIRED OR ELECTRICALLY HEATED**—to use whichever heat is most economical in your plant. No restriction on width. Electric furnaces heated with our proven cast alloy resistor elements, assuring highly efficient heating. None better.

✔ **EF JET OR STATIC COOLING**—jet or combined jet and static cooling, shortens the cooling section.

✔ **HYDROGEN, DISSOCIATED AMMONIA OR VACUUM PROCESSING.** Continuous vacuum furnaces, one of EF's latest developments, save on overall installation and operating cost.

✔ **COMPLETE UNIT RESPONSIBILTY**—furnished completely erected with all controls, terminal equipment and product handling, ready for immediate on-line operation.

For the highest finish, and most durable corrosion resistant surface, contact the EF heat treating engineers. ***You'll find it pays!***

EF

**THE ELECTRIC FURNACE CO.**

**Gas-fired, Oil-fired and Electric Furnaces for Heat Treating any Product, Using any Process, any Hourly Output.**

**300 West Wilson Street** *Salem - Ohio*

Branch Offices in Detroit, Mich., Santa Ana, Calif., and Cheshire, Conn. Canadian Associates, Canefco Limited, Scarborough, Ontario

From the pulpit, all operations of the new furnace are controlled by this operator with the help of Speedomax H instruments.

# Modern Automatic Controls by L&N Help Sheffield Meet Demand

*Speedomax® H regulates temperatures of new Drever heat-treat line*

THE boom is on down Texas way and the Sheffield Division of Armco Steel Corporation is keeping up with the demand for quality steel products by modernizing and expanding their Houston facilities.

A new remotely-controlled Drever roller hearth heat-treat line is among the major projects recently completed and placed in operation. Used presently for processing round bars up to 8" in diameter and up to 30' long, the line includes three furnaces: a 45' hardening furnace, a 45' holding furnace and a 124' tempering furnace.

Because temperature control in all the furnaces is critical, a total of 16 Speedomax instruments were chosen to provide detailed readout of temperature conditions and automatic adjustment of the gas valves. Six of these are easy-to-read Speedomax H indicating-controllers which regulate temperature in the 3-zone hardening and holding furnaces. Records of temperatures in these furnaces are printed out on two 3-point Speedomax G recorders. For the 8-zone tempering furnace, Speedomax H strip-chart controllers provide close control and reliable charting of temperature conditions in each zone.

Efficient installations such as this are the result of control engineering and design teamwork . . . teamwork that furnace manufacturers and users alike can depend on when specifications read, "control by Leeds and Northrup."

Take a tip from major companies like Sheffield and Drever. Call your nearby L&N engineer at one of 34 convenient offices. Or write 4942 Stenton Avenue, Philadelphia 44. We'll see that you get full information about the solution to your control requirements.

LEEDS NORTHRUP
Instruments Automatic Controls • Furnaces

# TRANTINYL GUIDES THE STEEL INDUSTRY

## U. S. Steel Gary Works rolled 100,000 TONS with this pair of "TRANTINYL" GUIDES

These entry guides on finishing stand, 14" mill, were photographed after rolling 100,000 tons of rounds. Guides were still in serviceable condition.

**14" Mill, Gary Works, with "TRANTINYL" Guides and Guide Box**

"Trantinyl" Guides and Rollers hold exceptionally high tonnage performance records, in serving leading steel mills for a quarter-century.

**Youngstown Alloy Casting Corporation**
**Youngstown, Ohio**

Sole Licensee to cast "TRANTINYL" for the Midwest, West and South: WAUNAKEE ALLOY CASTING CORP., Waunakee, Wis.

# HOT STRIP MILL

Designed and Built by MESTA

## FIRST with fully automatic controlled roughing mill

MESTA 44" Hot Strip Mill installation . . . including Vertical Edging Mill, Universal Reversing Roughing Mill, and six Finishing Mill Stands with three Finishing Vertical Edging Mills . . . at the Aliquippa Works of Jones & Laughlin Steel Corporation.

*Designers and Builders of Complete Steel Plants*

**MESTA MACHINE COMPANY**

**PITTSBURGH, PENNSYLVANIA**

# Personnel News...

**R. A. Shaw** has been appointed vice president of manufacturing operations for United States Steel Corp.'s American Bridge Division. Formerly executive assistant to the president of American Bridge, Mr. Shaw succeeds **R. B. Hunter,** who has retired. Mr. Shaw's career with American Bridge started in 1926 when he was employed as a clerk at the division's plant in Ambridge, Pa. He was appointed assistant manager of the Division's Trenton, N.J., plant in 1937. He returned to Ambridge in 1943 as plant accountant, serving in that capacity until his appointment as treasurer of American Bridge in 1949. During his tenure as treasurer of the division, Mr. Shaw also was named assistant secretary of United States Steel. He retained the latter post when he was advanced to executive assistant to the president of American Bridge in 1957.

**Walter E. Gregg** has been elected vice president—technology with Crucible Steel Co. of America. Mr. Gregg, formerly director of technology, takes over a position vacated last October when **Maurice J. Day** was named vice president—commercial.

**William Rodgers** was appointed chief metallurgist of Republic Steel Corp. Mr. Rodgers, formerly assistant chief metallurgist for the company, succeeds **Earle C. Smith,** former chief metallurgist and director of research, who died recently. **Andrew G. Forrest**, who had been serving as assistant to the chief metallurgist, succeeds Mr. Rodgers as assistant chief metallurgist.

Mr. Rodgers joined Republic in 1930 in the Metallurgical Department at the Buffalo, N.Y., plant. Prior to joining Republic, he was affiliated with the Donner Steel Co. of Buffalo, which was merged with Republic. In 1935, he was made district chief metallurgist at Buffalo. He was transferred to the Cleveland plant as district chief metallurgist in 1940 and subsequently became assistant general superintendent and later general superintendent of the 98-in. strip mill.

Mr. Forrest, before joining Republic in 1930 at the South Chicago, Ill., plant, was with Interstate Iron and Steel Co. which also was merged with Republic. After a number of different assignments, he was promoted to district chief metallurgist in 1944. He was transferred to Cleveland in 1957 as assistant to the chief metallurgist.

**Robert E. Edwards** has been named assistant superintendent—Open Hearth Department, Aliquippa Works, Jones & Laughlin Steel Corp. He succeeds **Joseph W. Zubaly,** who has retired. Mr. Edwards was formerly assistant superintendent—converting. **William D. Smith** has been appointed assistant superintendent—converting, succeeding Mr. Edwards. He formerly was general foreman—basic oxygen. At the same time, **Derek S. Harold,** was named general foreman—basic oxygen succeeding Mr. Smith, and **Frederick S. Kelsey** was appointed general foreman—open hearth.

**Regis F. Dunlavey** has been appointed superintendent of the Finishing Department at the Buffalo, N.Y., plant of Republic Steel Corp., **James C. Caher,** who had been serving as assistant chief inspector, was named to Mr. Dunlavey's former post of assistant superintendent of the Finishing Department. Mr. Dunlavey, who has been with Republic for the past 33 years, succeeds **L. R. Silliman,** recently named assistant plant manager.

**Charles N. Gilmore** has been appointed mine industrial engineer for the New York Ore Division of Jones & Laughlin Steel Corp. Mr. Gilmore, formerly an industrial engineer, succeeds **F. D. Woodworth,** who has resigned. Mr. Gilmore started in J&L's management training program as an industrial engineering trainee at the Pittsburgh Works in 1953. He was transferred to the Aliquippa Works Industrial Engineering Department in 1954. In 1955, he was appointed industrial engineer—raw materials at the corporation's headquarters in Pittsburgh. He was transferred to the New York Ore Division in 1956, as an industrial engineer.

**Robert E. Christian** has been named general superintendent and **David I. Odelius** has been named superintendent—normalizing at the Bagdad operation of West Leechburg Works of Allegheny Ludlum Steel Corp. Mr. Christian, who was formerly assistant to the works

R. A. SHAW

W. E. GREGG

WILLIAM RODGERS

A. G. FORREST

R. E. CHRISTIAN

R. G. BIRKIN

J. G. FRISCHKORN

J. A. FARNSWORTH

manager, special assignments, joined Allegheny Ludlum in 1950. In 1955, he was appointed metallurgist, quality control laboratory, West Leechburg Works. A year later he was made assistant to the general superintendent, finishing, and in 1957 he was appointed to serve as assistant to the works manager, special assignments. Mr. Odelius joined Allegheny Ludlum at West Leechburg Works in 1935. He worked in the finishing and slitting departments until 1947, when he was made turn foreman, slitting and stamping section, in the Finishing Department. Within two years he was appointed assistant superintendent of the same section, and in 1955 he was named superintendent, silectron finishing, in the Specialty Department, a post he held until his recent promotion.

**Robert G. Birkin** has been named general sales manager, and **J. G. Frischkorn,** sales manager, of the Cleveland Crane & Engineering Co. Mr. Birkin has been with the company in various capacities for 33 years. Last year he was appointed sales manager of the Heavy Machinery Division. Prior to that he was Eastern district sales manager of the Heavy Machinery Division. Mr. Frischkorn was sales manager of the Cleveland Tramrail Division. He has also worked in the Engineering Department and as Cleveland Tramrail district sales manager.

**J. A. Farnsworth** has been named manager of the Mead-Morrison Division of the McKiernan-Terry Corp. He joined Mead-Morrison in 1956 as mid-Atlantic States sales engineer.

**William J. Feahr** has been appointed divisional sales manager of the newly-combined Pittsburgh and Great Lakes Divisions of the Crouse-Hinds Co. He succeeds **J. J. Bangert** who has retired. Mr. Bangert joined Crouse-Hinds in 1920 as a salesman in the Pittsburgh area. In 1938, he was named regional manager of the Pittsburgh office. He became divisional manager of the Pittsburgh and Cincinnati offices in 1943, which position he held until his retirement. Mr. Bangert is a life member of the AISE and has long been active in Pittsburgh district activities. **R. I. Browning,** formerly of the San Francisco office, has been named Pittsburgh regional manager.

**Michael G. Sendzimir** has been appointed president of T. Sendzimir, Inc. He succeeds **Tadeusz Sendzimir** who becomes chairman of the board. At the same time, **Andrew T. Romer** was appointed vice president, and **Stefan Jedrzejewski,** sales manager.

**William H. Thomas** has been named technical assistant to the vice president of the Coke and Iron Division of Pittsburgh Coke & Chemical Co. Mr. Thomas who joined the company in 1941 as a plant engineer, was formerly general superintendent of the Coke and Iron Division.

**Michael N. Baker** has been appointed an associate of the NADCO Engineering Co.

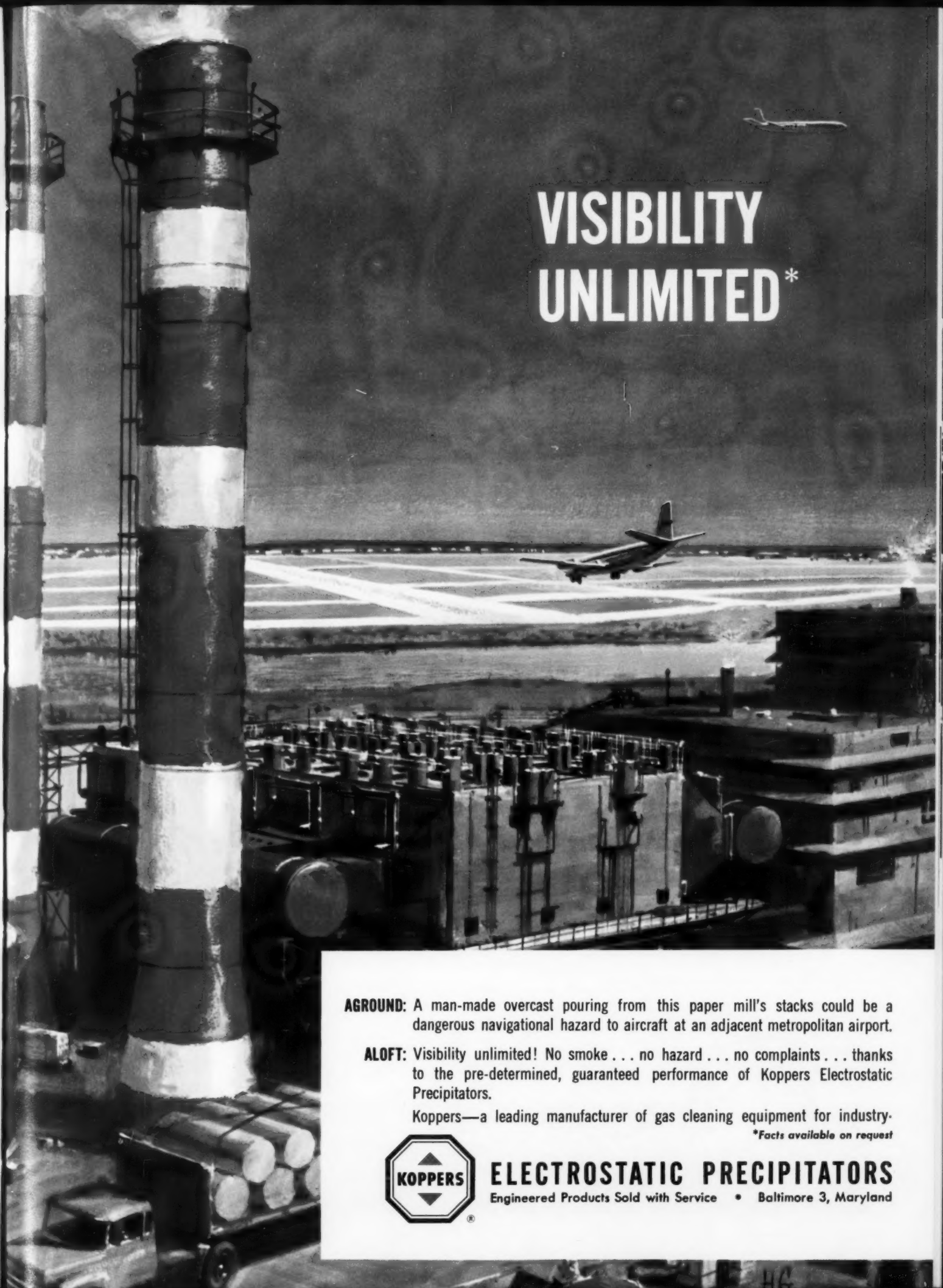
**Harold L. Russell** has been named product sales manager in charge of process instrument sales for Daystrom, Inc., Weston Instrument Division. Mr. Russell comes to Weston from the Fischer and Porter Co., where he served as general sales manager. Earlier he was a field sales engineer with the industrial division of Minneapolis-Honeywell Regulator Co.

**Charles D. Brown** has been appointed manager—marketing at General Electric Co.'s Instrument Department, West Lynn, Mass. He was previously manager of marketing at the company's Light Military Electronics Department, Utica, N.Y., a position held since 1956.

**H. R. Fulton,** formerly manager of the Pittsburgh district, was named regional sales manager of Bailey Meter Co.'s eastern district offices. At the same time **A. L. Danielsen,** former manager of the Denver district, has been appointed regional sales manager of the company's western district office.

H. R. FULTON

A. L. DANIELSEN




**AGROUND:** A man-made overcast pouring from this paper mill's stacks could be a dangerous navigational hazard to aircraft at an adjacent metropolitan airport.

**ALOFT:** Visibility unlimited! No smoke . . . no hazard . . . no complaints . . . thanks to the pre-determined, guaranteed performance of Koppers Electrostatic Precipitators.

Koppers—a leading manufacturer of gas cleaning equipment for industry.

**Facts available on request*

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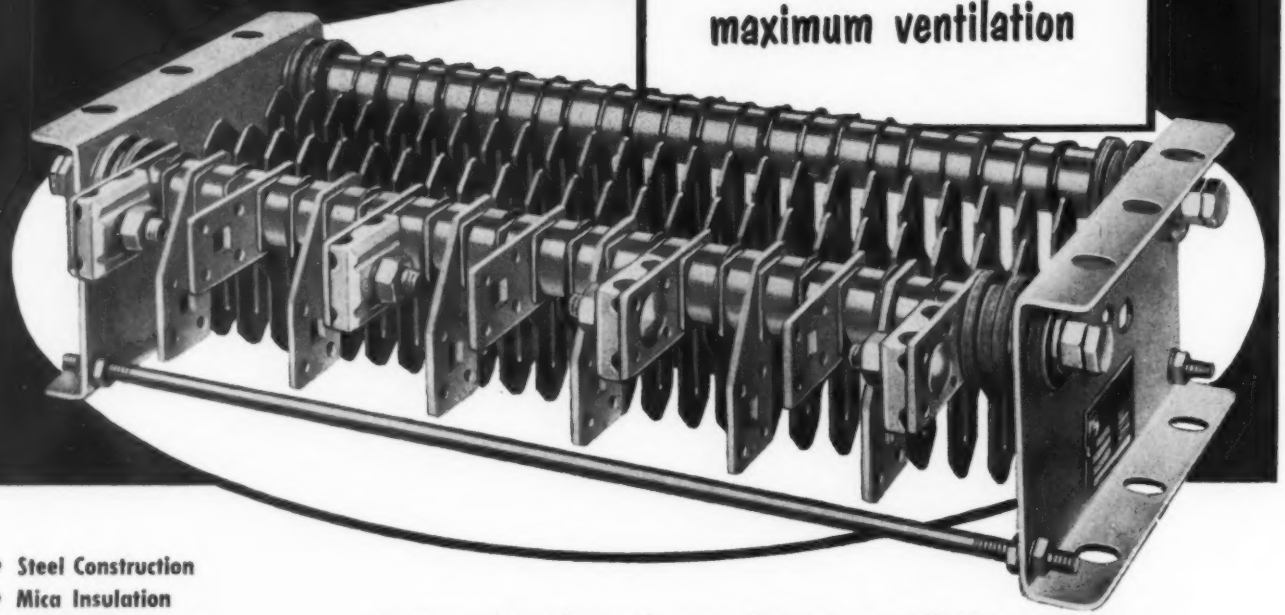
# Resistor life depends on adequate ventilation.....

Patented P-G Grid

Design assures maximum ventilation



- Steel Construction
- Mica Insulation
- Corrosion Resistant
- Vibration Proof
- Moisture Resistant
- Provision for Expansion
- Adequate Ventilation
- Rugged Terminals

*Write for Bulletin No. 500*

Resistor life depends on adequate ventilation and how efficiently heat may be dissipated . . . P-G grid design equalizes the amount of air space surrounding each leg or loop to obtain even heat throughout the grid area. (Note illustration.) . . . Since heat is rapidly and evenly dissipated, hot spots fail to develop and longer resistor life is assured . . . For a nonbreakable resistor (only steel and mica used) specify P-G on your next application.

*The Nonbreakable Steel Grid Resistor*

P-G

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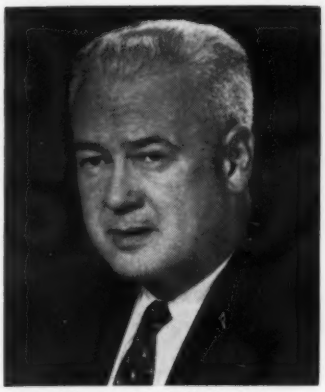
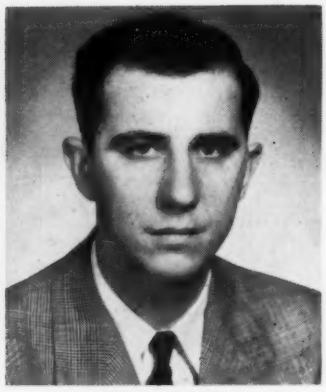
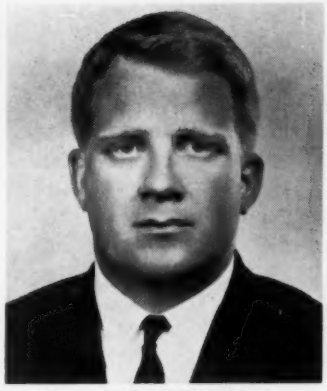


W. J. CRAWFORD



T. E. BAN



C. T. HEPPENSTALL

W. G. CRONK

**William J. Crawford** has been appointed production manager of Heyl & Patterson, Inc. Mr. Crawford has been associated with the company in various supervisory capacities since 1944.

**Thomas E. Ban** has been elected vice president—research of McDowell Co., Inc. Mr. Ban joined McDowell in 1955 as director of research.

**Charles T. Heppenstall** has been appointed manager of specialty product sales for Heppenstall Co. He started with the company in 1955 as a trainee and subsequently served in the Metallurgical Department. Since 1959 he has been manager of materials and production at the New Brighton, Pa., plant.

**William G. Cronk** was named assistant to the president of The H. K. Ferguson Co. He was formerly vice president of Patterson-Emerson-Comstock, Inc. Previously, he was associated with Acindar, S. A., of Argentina and while resident there took part in engineering and construction of new plant facilities.

**Walter I. Weed** has been appointed supervisor of quality control at the Detroit, Mich., plant of Jones & Laughlin Steel Corp.'s Stainless and Strip Division. He joined Jones & Laughlin in 1954 as a metallurgist.

**Richard D. Whetstone** has been named eastern division manager of industrial carbon sales for National Carbon, Co., Division of Union Carbide Corp. Mr. Whetstone joined National Carbon in 1953 in the production organization at its Clarksburg, W. Va., plant. Transferring to sales in 1954, he has served in Chicago, Houston, and Kansas City prior to his new assignment.

**Jack L. Schumann** has been elected president and a director of Buell Engineering Co., Inc. He succeeds **J. A. McBride,** who will continue as a board member and consultant. Mr. Schumann joined Buell in 1946, as a sales engineer.

**Joseph W. Collier** has been named chief industrial engineer by Latrobe Steel Co. Mr. Collier was previously affiliated with the Pittsburgh Plate Glass Co. at its Crystal City, Mo., plant as assistant industrial engineer for more than 12 years.


*Spherical*
**SHOCK**
TRAP® for
**WATER LINES**
**Eliminate water hammer and pipeline bursting. Save piping and plant costs with guaranteed surge limits.**

PATENTS PENDING

**PULSCO®**

Designed primarily for shut-down or shut-off application, this unit is used in pumping plants, irrigation systems, fire control on rocket test stands, municipal water systems, etc. Of the water interface type, the Pulsco swirl principle reduces pressure and reduces shock and surge resulting from kinetic energy within the pipeline, this by compressing gas within the chamber and by friction through the swirl chamber.

Guaranteed not to recycle, this Pulsco Spherical Shock Trap is built for pressures to 200 PSIG and up. Sizes from 34 to 102 inches diam.

**PULSCO *Bellows* SHOCK TRAP**
**For AIRCRAFT AND MARINE FUEL LOADING SYSTEMS JET FUEL AND GASOLINE**

Take the "hammer" out of high velocity fuel lines — removes the danger of broken lines, meters, and overstressed loading equipment. Assure correct meter readings consistently with this Pulsco scientifically designed Bellows Shock Trap — the best for quick STOP and GO liquid lines.

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Slitting and Coiling Lines
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Culvert • Steel Mill Equipment

**STAMCO, Inc., New Bremen, Ohio**

**William B. Wallis** and **Ernest W. Weaver** have been presented the Trinks Award, highest honor in the industrial heating equipment industry. The Award, sponsored by *Industrial Heating* publication, and bestowed annually by a judges' panel of industrial heating authorities, is named for **Dr. Willibald Trinks,** professor emeritus of Carnegie Institute of Technology, world authority on industrial heating, and a member of the panel. Other judges are: **Dr. John C. Warner,** president of Carnegie Institute of Technology, and **T. J. Ess,** managing director of the Association of Iron and Steel Engineers and editor of *Iron and Steel Engineer.* Mr. Wallis, consulting engineer for Strategic Materials Corp., was cited for his numerous inventions and engineering achievements which have aided greatly in bringing about the present acceptance—throughout industry—of the electric arc melting furnace; and for 45 years of personal leadership devoted to fostering the growth of this segment of the industrial heating field.

Mr. Weaver, a mechanical engineer, and retired engineering executive of Surface Combustion, was cited for his lifelong achievements in design and construction of furnaces for heat treating of metals.

**Daniel E. McDade** has been named manager of the new Charleston, W. Va., district office of I-T-E Circuit Breaker Co. He has been a field application engineer in I-T-E's Philadelphia district office for seven years.

**R. F. Protiva** has been named manager of the Cleveland, Ohio, plant of Heil Process Equipment Corp. He joined the company as sales engineer in 1940. He became manager of process industry sales in 1956, Eastern sales manager in 1957 and manager of market development in 1959.

**H. J. Urbach,** formerly company executive engineer, has been given the title of director of engineering, The Timken Roller Bearing Co.'s Engineering Division. **Ralph E. McKelvey,** formerly assistant chief engineer of the Physical Laboratories, has been promoted to assistant director of engineering. Mr. Urbach joined Timkin in 1933 in the Railway Engineering Department. Two years later he was made design and service engineer in the Diesel Fuel Injection Department. In 1939 he was promoted to mechanical engineer, special projects, and was made works engineer in 1945. He was promoted to executive engineer in 1951.

Mr. McKelvey started his career with Timken in 1948 as a test engineer in the Physical Laboratory in Canton, Ohio. He was made project engineer of the Physical Laboratory in 1953. He was promoted to assistant chief engineer of the Physical Laboratories in 1959 when the Lubrication Laboratory, Railway Research Laboratory and Physical Laboratory were combined.

**T. A. Thompson** has been appointed superintendent and **Roy A. Pulse,** assistant superintendent in the Open Hearth Department at Weirton Steel Co. division of National Steel Corp. Mr. Thomson, who was advanced from the position of assistant superintendent, began his employment with Weirton in 1937 in the Electric Department. Four years later he was transferred to the Fuel Department and worked there until 1943 when he was moved to the 10–16 in. Strip Steel

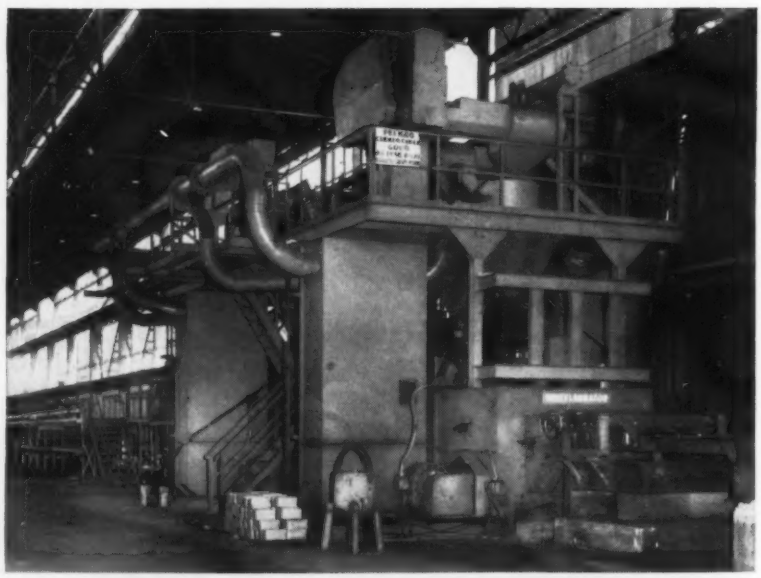

EXECUTIVE REPORT #11

# HERE CARBON STEEL SHEDS ITS SCALE

## Wheelabrator® Descaling Enables 100% Increase in Production

**Every ton of steel produced in the modern mill of Altos-Hornos De Mexico, S.A., at Monclova, Coahila, is run through a Wheelabrator airless blast descaling cabinet. In a typical month, over 15,500 tons of carbon steel from a hot Steckle reversing type mill was Wheelabrator descaled followed by a light pickle rinse. The end product is reduced on reversing cold mills for sale as cold rolled steel, tin plate, and galvanized stock.**

**Steel is descaled in this new line at a rate of up to 200 f.p.m. contrasted to a speed of only 100 f.p.m. when acid pickling was used exclusively for descaling. Even with this increase in production, acid consumption has been cut in half and overall descaling costs materially reduced.**



**Wheelabrator Engineering Experience At Your Service**

Write today for information on how Wheelabrator descaling can cut your costs and speed production. Wheelabrator Corporation, 396 S. Byrkit St., Mishawaka, Indiana. In Canada, P.O. Box 490, Scarborough, Ontario.

**WHEELABRATOR**
**AIRLESS BLAST EQUIPMENT**

Department. In 1944 he became a forge furnace heater in the Shell Plant, working there until 1945 when he was named fuel engineer. In 1948 he was appointed combustion engineer in the Open Hearth Department, three years later was named assistant turn superintendent, and in 1957 became assistant superintendent of the Open Hearth. Mr. Pulse began his employment with Weirton in 1929 in the Open Hearth Department and has spent his entire career with the company in that department. In 1930 he was promoted to third helper, became a second helper in 1941, first helper in 1944 and four years later became a melter, serving in that position until his current appointment.

**Carmel J. Ruffo** has been named superintendent of basic maintenance at Pittsburgh Coke & Chemical Co. Mr. Ruffo joined the company in 1936 and has served as general foreman of the coke plant and general foreman of basic maintenance. Prior to his recent appointment he had been assistant superintendent of basic maintenance.

**Emil A. Axelson** was appointed Pittsburgh district sales manager, Refractories Division, H. K. Porter Co., Inc. He was formerly a steel mill specialist with the division. Before joining Porter Mr. Axelson was assistant open hearth superintendent for Bethlehem Steel Co.

**Milton C. Stafford** has been appointed manager of product sales of the Jones Machinery Division, Hewitt-Robins Inc. He was formerly Chicago district manager for Jones products.

**L. L. Whitney, Jr.,** has joined the Metallurgical Service Division of Union Carbide Metals Co., division of Union Carbide Corp. Mr. Whitney will serve as a member of the foundry service group in the Cleveland offices of the Metallurgical Service Division. Prior to joining Union Carbide Metals, he was associated with Inland Steel Co., American Steel Foundries, and West Michigan Steel Foundry.

## *Obituaries*

**D. M. Petty,** past president of the Association of Iron and Steel Engineers, and former president of the Philadelphia, Bethlehem & New England Railroad Co., died recently. Mr. Petty had served with the Bethlehem Steel Co. for 50 years, serving as assistant electrical engineer, electrical superintendent, superintendent of the Service Division, and superintendent of railroad properties. He was subsequently appointed president of the Philadelphia, Bethlehem & New England Railroad Co. Mr. Petty had been a member of the AISE since 1911, and had served on numerous committees. He was elected president of the Association in 1919.

**Edward J. McDonnell,** former vice president in charge of steel plant equipment sales in the Equipment Division of Blaw-Knox Co., died June 7.

**John S. Morris,** formerly supervisor construction, central maintenance, Lukens Steel Co., died June 11. Mr. Morris had been very active in the AISE.

**Joseph S. Mohr,** General Refractories regional sales manager, Chicago, Ill., died May 22.


EXECUTIVE REPORT #12

# A PIPE DREAM COMES TRUE

## Wheelabrator® cleans skelp edges at new low cost

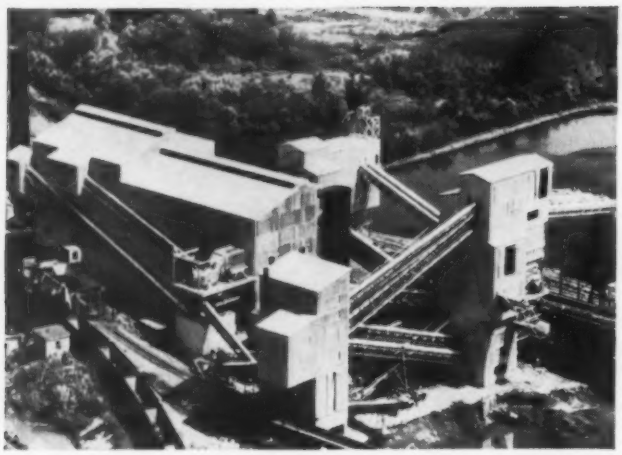
Another example of steel industry savings made possible by Wheelabrator mechanical descaling is the exceptional economy realized by pipe rolling mills in cleaning of skelp. Here it is desired to clean only a small strip along both edges of the bottom side of the skelp, which will be butted together and electro-welded.

In the Wheelabrator process, two blasting wheels are positioned to pinpoint their abrasive barrage along the edges, giving fast, thorough cleaning of these surfaces only.

**Wheelabrator leads in mechanizing steel mill descaling methods**

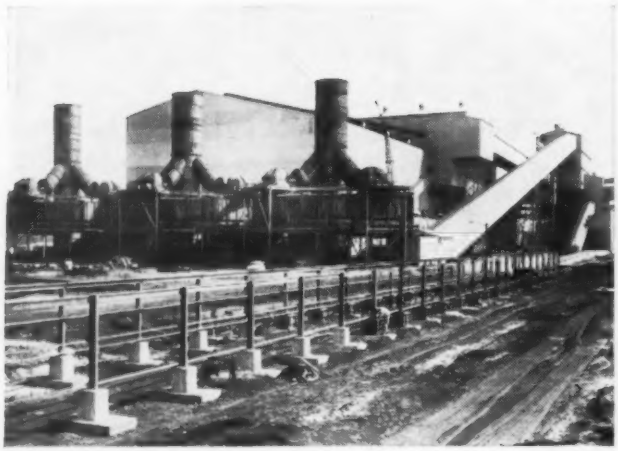
In over 100 installations in all types of steel mill applications, Wheelabrator has proven its cost-saving benefits. For engineering consultation call or write Wheelabrator Corporation, 396 S. Byrkit St., Mishawaka, Indiana. In Canada, P. O. Box 490, Scarborough, Ontario.

# First these:

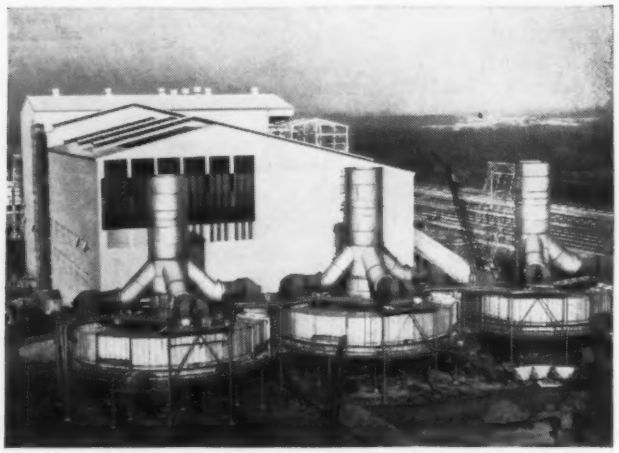


ARMCO

McLOUTH



GARY



SAXONBURG

# and now:

# THE WORLD'S LARGEST SINTER MACHINE

Sinter machine width: 13′ 2″

Sinter machine length: 184′

Sinter machine area: 2419 sq. ft.

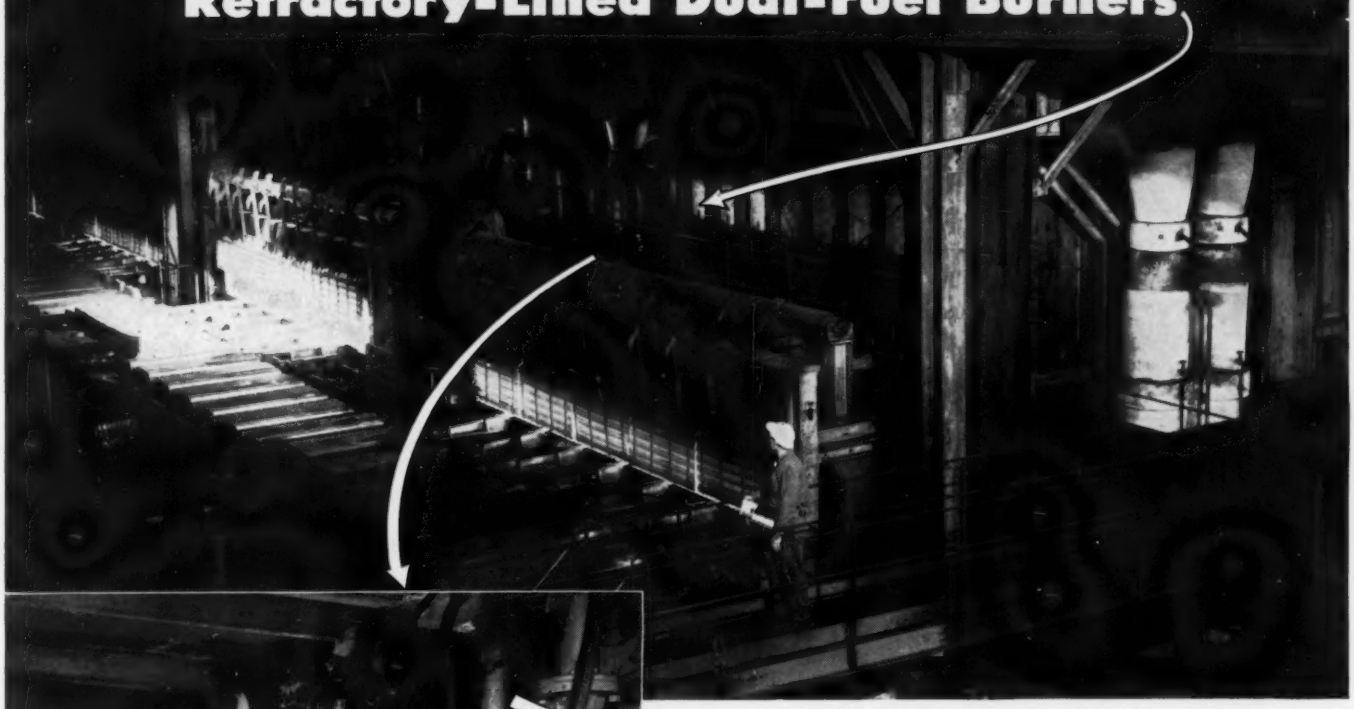
Engineering constructor—Dravo Corporation

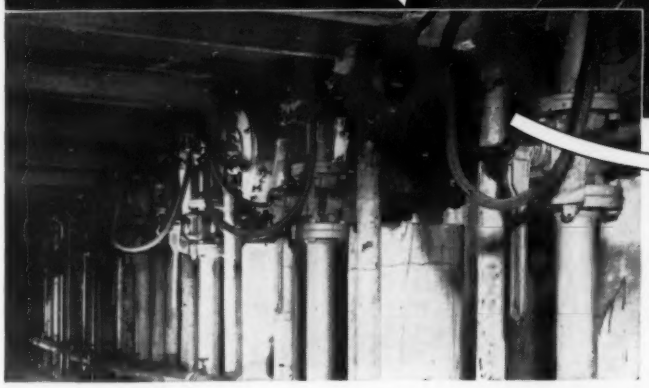
For: Jones & Laughlin Steel Corporation, at Aliquippa, Pennsylvania

DRAVO LURGI

DRAVO
CORPORATION
PITTSBURGH 22, PA.

# ARMCO uses North American
## Refractory-Lined Dual-Fuel Burners





Four new Salem-Brosius slab heaters in Armco Steel Corporation's Middletown Works Hot Strip Mill are fired with North American Series 6819 Burners with internal mixing oil atomizers and Sensitrol Valves. Air is preheated to 700 F. Fuel is natural gas or #6 oil.

The top bank of each furnace has eight 10" burners and two 8" burners firing in the direction of work travel; bottom bank has five 10" burners and two 8" burners firing in the opposite direction. Each 10" burner releases 5,200,000 Btu/hr with 700 F air at 2" wc; each 8" burner releases 3,600,000 Btu/hr.

Furnaces are 27' wide x 34' long inside, and are designed for 125 tons of hot slabs per hour.

## Here's Why You Should Too:

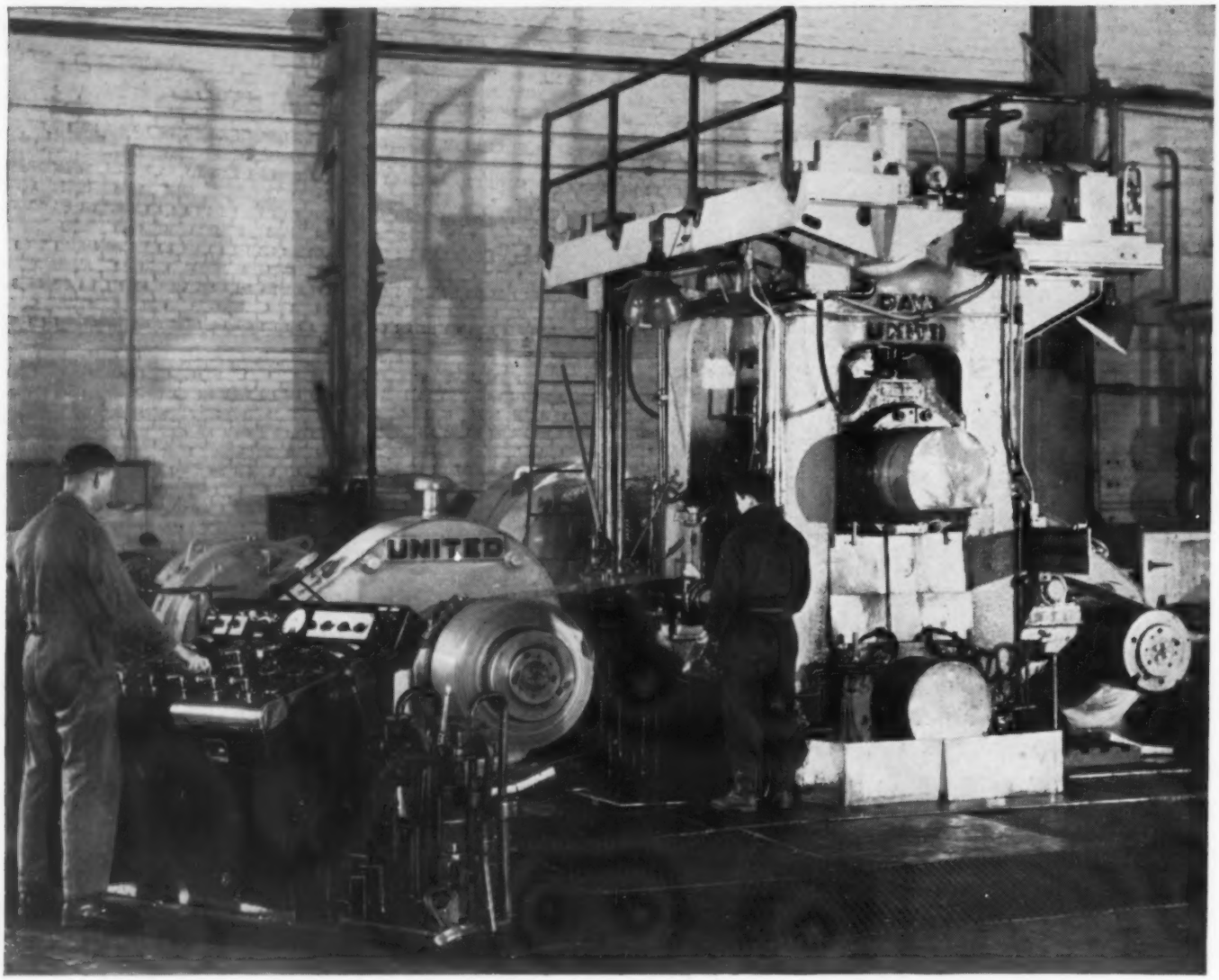
1. **Low maintenance**—quality alloy and refractory materials—metal parts not exposed to furnace radiation—designed for 1200 F preheated air.
2. **Easy accessibility**—quick disconnect atomizer—all parts removable from back.
3. **Retractable oil atomizer**—can be pulled back quickly and easily for gas firing.
4. **Gas and air openings proportional** for all sizes; so a variety of burner sizes can be used on the same manifold.
5. **Long or short flame** models available.
6. **Internal or external mixing atomizers** available.
7. **Low first cost**—plus North American's reputation for good service—in engineering and on the job site.

NORTH AMERICAN for COMBUSTION and Hydraulic Controls

Call your nearby North American engineer or write for DF 6819

**The North American Mfg. Co.**
**Cleveland 5, Ohio**

# AUTOMATION IN STRIP ROLLING




Photograph by courtesy of Lancashire and Corby Steel Manufacturing Co. Ltd.

Instrument engineering is one of the many new technologies helping the Metals Industries towards greater output and better product quality.

Davy-United have recently designed a range of indicating and controlling instruments to assist mill operators in rolling strip faster and to closer gauge. Illustrated here is the first industrial system of high performance automatic gauge control equipment installed on a cold rolling mill, operating under full production conditions.

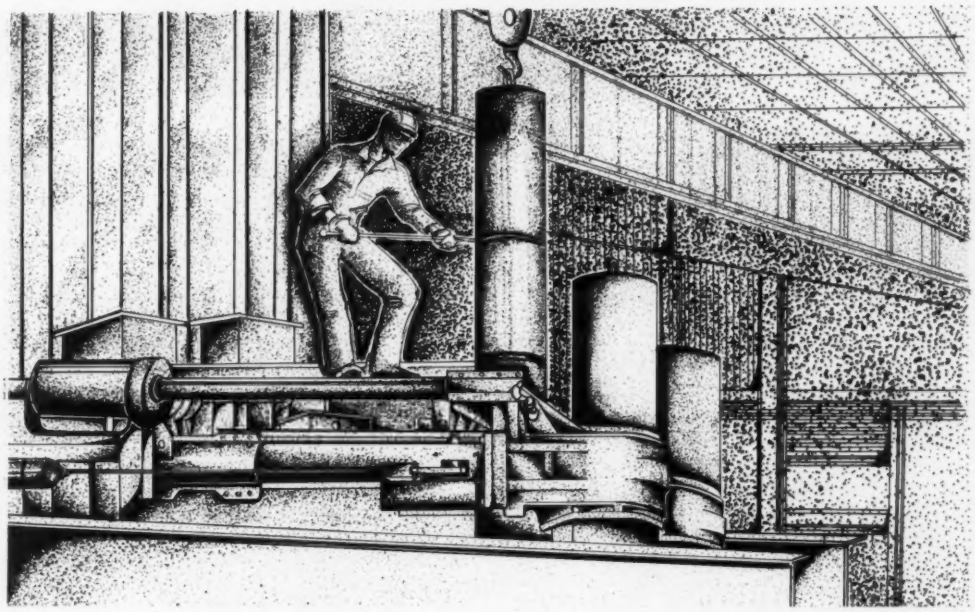
These, and other Davy-United instruments such as a precision width meter for hot mills, and radiation thickness gauges both for mills and strip processing lines, are daily bringing nearer the eventual target of the automatic mill.

**DAVY-UNITED**

337/DU

DAVY AND UNITED INSTRUMENTS LIMITED, DARNALL WORKS, SHEFFIELD 9

# ELECTRIC STEEL MAKERS CAN DEPEND UPON PROMPT GLC SERVICE



GLC electrode service technicians make it the rule rather than the exception to respond to a service call within 24 hours.

Whenever a customer experiences an undue rise in electrode consumption, every resource of the GLC Electrode Division is at his command.

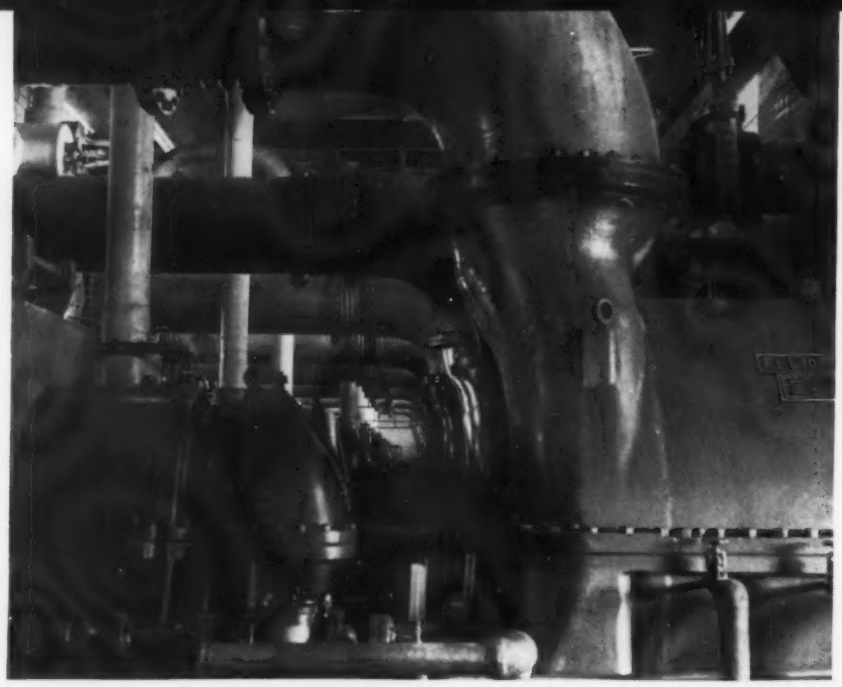
GLC customer service technicians have had broad experience in melt shop practice and problems. Their record of prompt, effective service to electric furnace operators everywhere is striking evidence of their dedication to the customer's welfare.

We invite you to call upon the time and talents of these men whenever the need arises.

PRODUCTS ELECTRODE GLC DIVISION YOU CAN TRUST®

**GREAT LAKES CARBON CORPORATION**

18 EAST 48TH STREET, NEW YORK 17, N. Y. OFFICES IN PRINCIPAL CITIES



At Weirton Steel Company, eight Elliott compressors (photo right) serve a battery of 253 coke ovens. Four are exhausters rated at 24,500 inlet cfm, and four are boosters rated at 25,000 inlet cfm. All are driven by Elliott turbines.

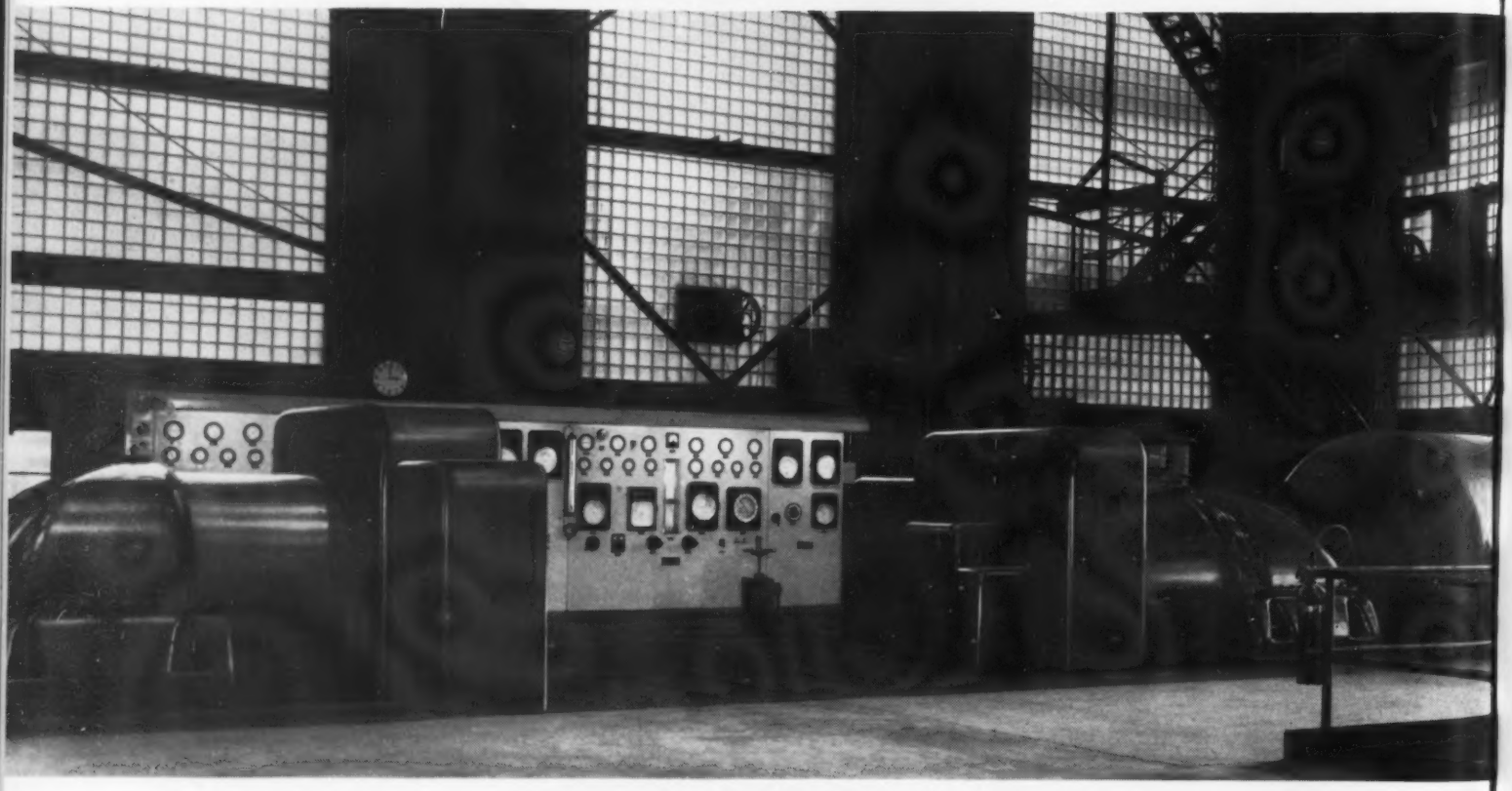


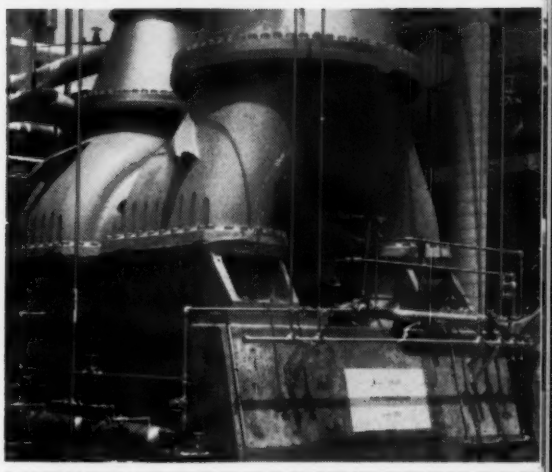
Photo above shows duplicate Elliott blast furnace compressors. Each is rated at 99,600 inlet cfm, and is driven by an 11,800-hp Elliott turbine.

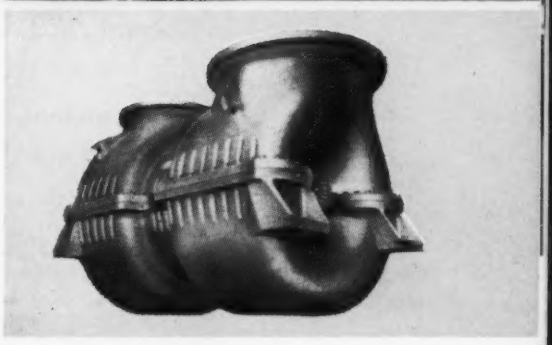
At the right are shown two of three Elliott centrifugal air compressors operating in a single blast furnace plant. All three units—driven by Elliott turbines—are rated 90,000 scfm at 30 psig air discharge.

*Engineered and built for Blast Furnace and Coke Oven Service . . .*

# ELLIOTT CENTRIFUGAL AND AXIAL COMPRESSORS

Extensive experience in the design and application of centrifugal compressors is reflected in the excellent performance of Elliott machines for blast furnace and coke oven service. Since 1926, Elliott has made industrial compressors, and many of these are furnishing air for blast furnaces, and serving as boosters and exhausters for coke ovens. Typical examples are illustrated on these pages.





Multi-stage compressors of the axial flow type are designed and engineered specifically to serve the needs of the iron and steel industry for the handling of air or gas mixtures in large volume flow operation. Frame sizes are rated up to approximately 600,000 cubic feet per minute when operating on air.

## COORDINATED ELLIOTT DRIVERS

Elliott is a leading manufacturer of both steam turbines and electric motors, of all types and ratings necessary to provide driving power for compressor units. Consequently, we are in position to recommend and furnish the type of drive best suited for each application. Both units being engineered and built by Elliott is a decided "plus" because it means unified responsibility, unified service.

## FOR AIR OR GASES

Elliott integrated compressor units are available for handling all types of compressible fluids, within the pressure and flow limits of the machines. Where corrosive gases are handled, special materials are employed in vulnerable spots; where high pressures are needed, extra heavy construction is used; where leakage must be prevented, special shaft seals are available; where high temperatures must be avoided, provision is made for cooling.

## 48 STANDARD FRAME SIZES

A total of 48 frame sizes permits accurate compressor application over the entire range of 500 cfm to 600,000 cfm. Pressures and speeds can be selected to meet the characteristics of the application, and the gas to be handled. For further information, write Compressor Department, Jeannette, Pa.

**ELLIOTT** THE MOST COMPLETE LINE OF **INTEGRATED COMPRESSOR & DRIVER UNITS** 500 cfm to 600,000 cfm

**ELLIOTT** Company
Jeannette, Penna.

# New heat-resistant alloy

# SUPERTHERM

(Trade-mark)

# for castings operating in the 1800-2300°F range

DEVELOPED AT OUR RESEARCH LABORATORIES

in Mahwah, N. J., Supertherm is field tested and proved. It is a superior alloy in this temperature range for static, centrifugal and shell-molded castings.

Mail the coupon, below, for technical information on composition*, physical and high-temperature properties.

*Patent Pending

---

Electro-Alloys Division
2037 Taylor Street
Elyria, Ohio

Please send me technical information on SUPERTHERM

Name _____

Title _____

Company _____

Address _____

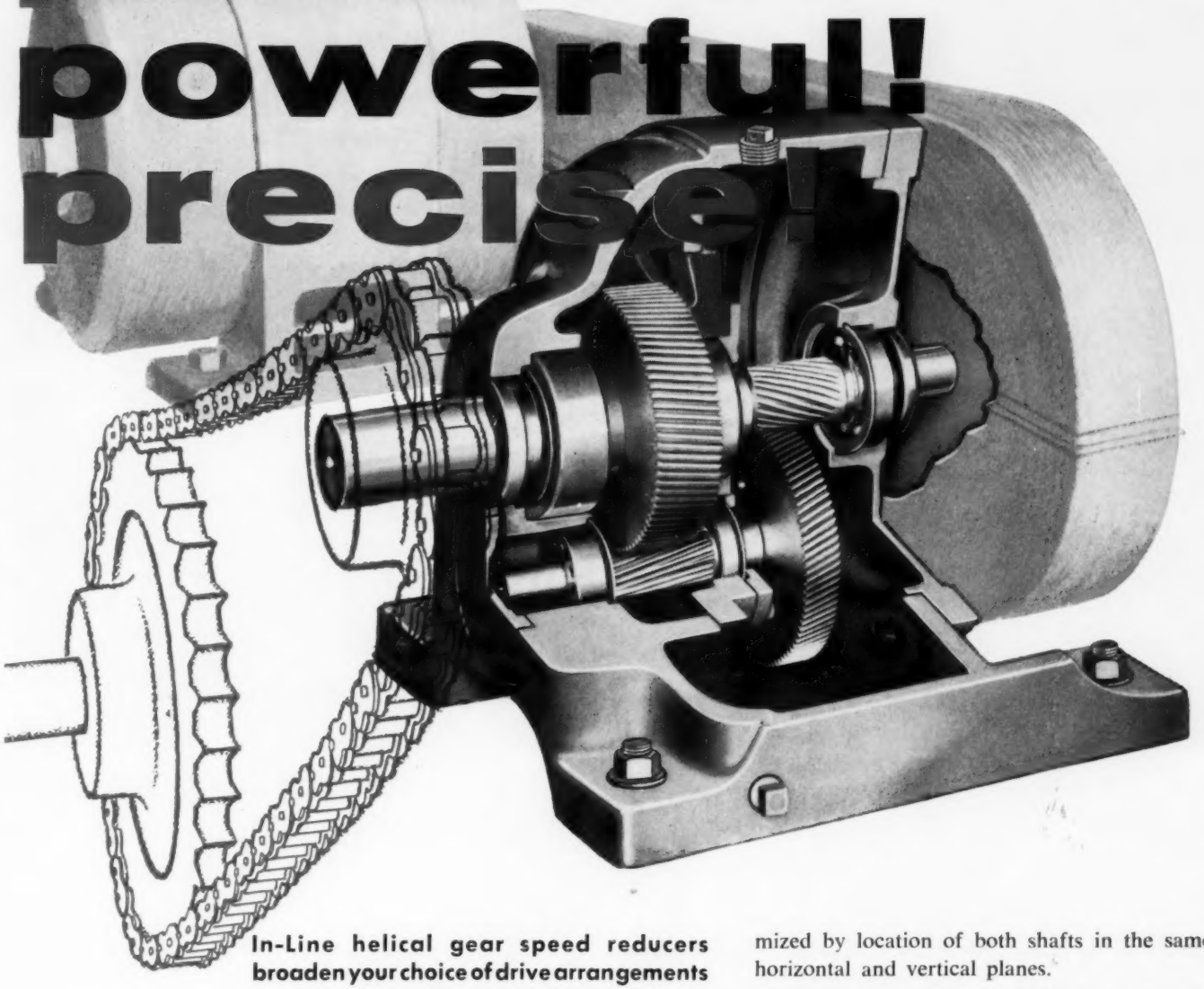
City _____ Zone ___ State _____

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION • Elyria, Ohio

LINK-BELT IN-LINE HELICAL GEAR SPEED REDUCERS . . .

# positive! powerful! precise!



**In-Line helical gear speed reducers broaden your choice of drive arrangements**

No limit to the number of compact drive set-ups you can arrange with a Link-Belt In-Line helical gear speed reducer. Mount the motor where you will—it needn't be direct-connected. Space demands and layout problems are minimized by location of both shafts in the same horizontal and vertical planes.

Built for hard work, these drives feature the simplest of gear arrangements. Housing is one piece—sturdy and well sealed. Stocked in double, triple and quadruple reductions—up to 206 hp, ratios to 2217:1.

FOR FULL-LINE FACTS

on Link-Belt's comprehensive line of speed reducers—contact your nearest Link-Belt office or authorized stock-carrying distributor . . . or check and send this coupon to Link-Belt Company for data on all or any combination of the following:

- ☐ gearmotors—Catalog 2747
- ☐ motogears—Catalog 2747
- ☒ In-Line helical gear speed reducers—Catalog 2751
- ☐ shaft-mounted speed reducers—Catalog 2618
- ☐ worm gear speed reducers—Catalog 2324-A
- ☐ universal worm gear speed reducers—Catalog 2724
- ☐ parallel shaft speed reducers—Catalog 2619
- ☐ fluid drives—Catalog 2747
- ☐ P.I.V. speed changers—Catalog 2274

LINK-BELT

15,105

PRUDENTIAL PLAZA, CHICAGO 1, ILL.

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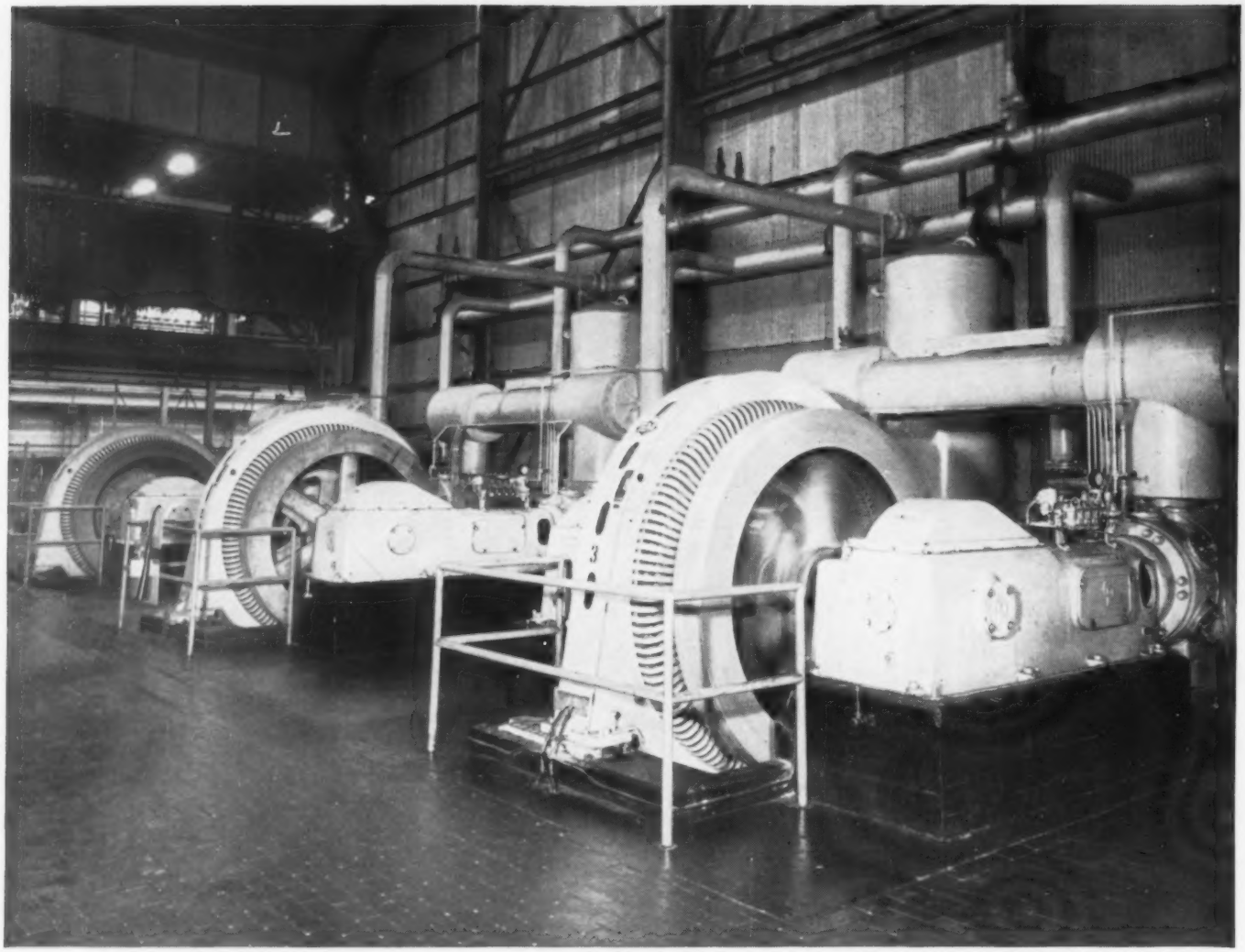


Above are three 500 hp, 225 rpm, 2300 volt, 0.8 power factor E-M Synchronous Motors driving air compressors in the tin finishing department at the new Fairless Works of United States Steel Corporation. Three other 500 hp and five 300 hp E-M Motors also drive air compressors, in the hot strip and slab mill, central power station, open hearth pumphouse and sulfate building of the coke works.

# Power costs held low on compressor drives at new Fairless Works

Supplying air for controls, tools, handling systems and maintenance equipment is vital business at Fairless Works. And cost of power for operation of the air compressors is an item to be watched in such a large mill.

That's exactly where the E-M Synchronous Motors fit in. They help contribute real economy and rugged reliability to compressor operation.

**First of all,** these 11 E-M Motors are capable of supplying approximately 2700 reactive kva to improve plant power factor, a significant element when you want to minimize power costs.

**Secondly,** the inherent high efficiency of E-M Synchronous Motors utilizes power most sparingly.

Other economies are accomplished by use of simple and low-cost full-voltage control for across-the-line starting. Maintenance economy is foretold by simplicity of E-M Synchronous Motor direct-connection . . . by extra strong lashing of E-M stator coils . . . by the high capacity of E-M cage windings to withstand repeated starting stresses.

To get top performance from your large compressor drives, discuss your needs with your nearest E-M sales engineer. And write factory for E-M Synchronizer No. 42, a special issue on the ABC'S of Synchronous Motors.

**ELECTRIC MACHINERY MFG. COMPANY**
**MINNEAPOLIS 13, MINNESOTA**

E-M

1200-TPA-2168A

*Specialists in making motors do*
**EXACTLY WHAT YOU WANT THEM TO**

# Pint size...KING size...every in-between size

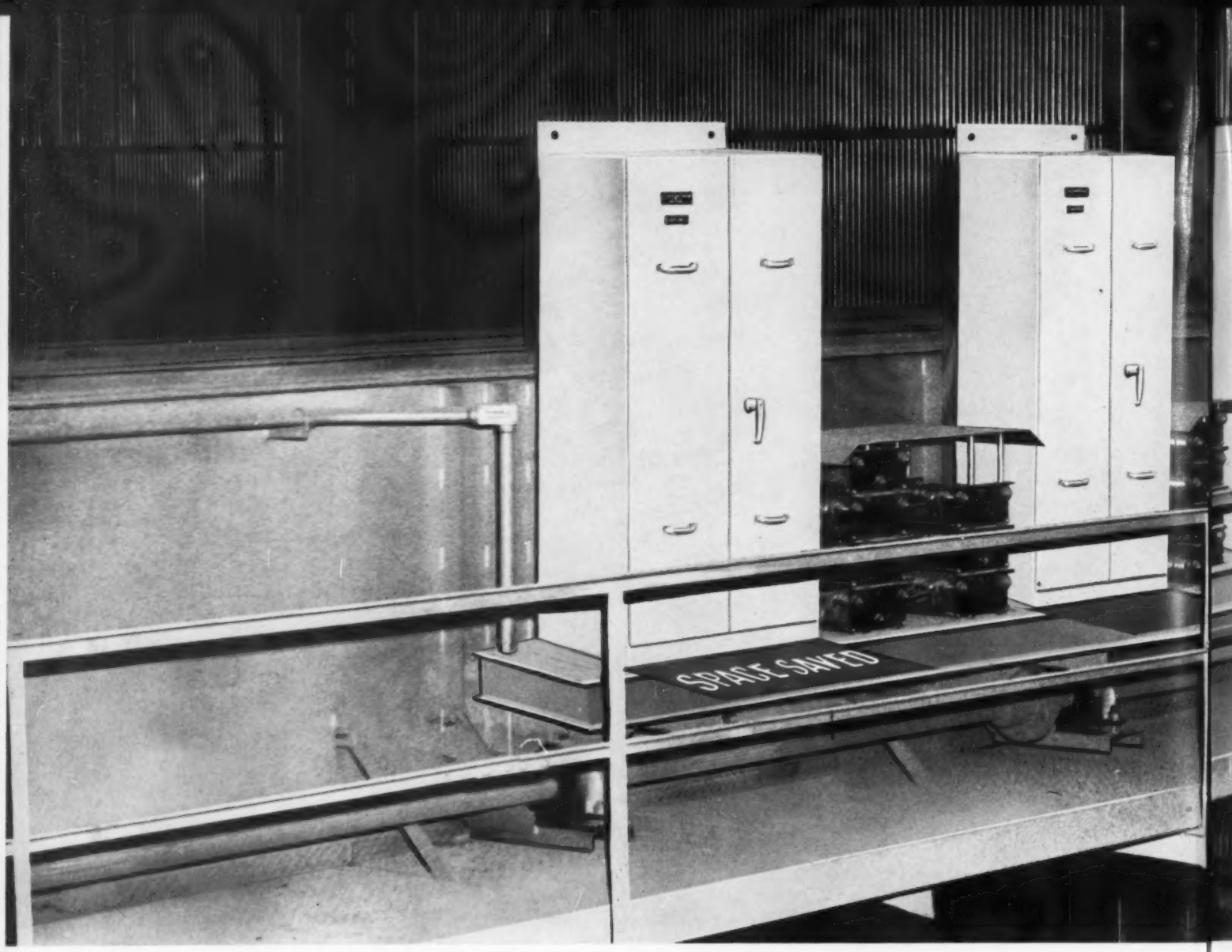
Bethlehem forges hardened-steel rolls of every size, shape, hardness, and finish. You can count on us for good delivery. And every roll will meet your exact specifications. Try us next time you need rolls for cold-rolling steel sheet, strip, tinplate, or non-ferrous metals.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
*Export Distributor:* Bethlehem Steel Export Corporation

Steel
For strength
... economy
... versatility

**BETHLEHEM STEEL**

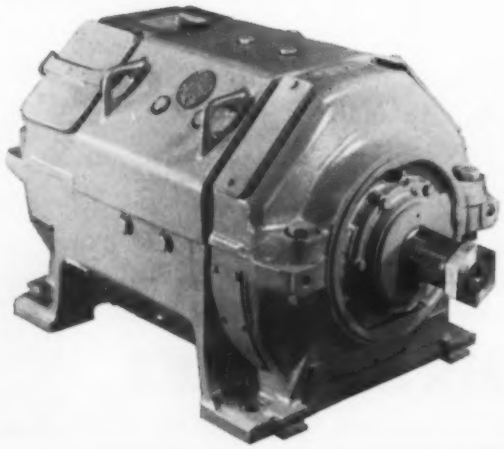
BETHLEHEM STEEL



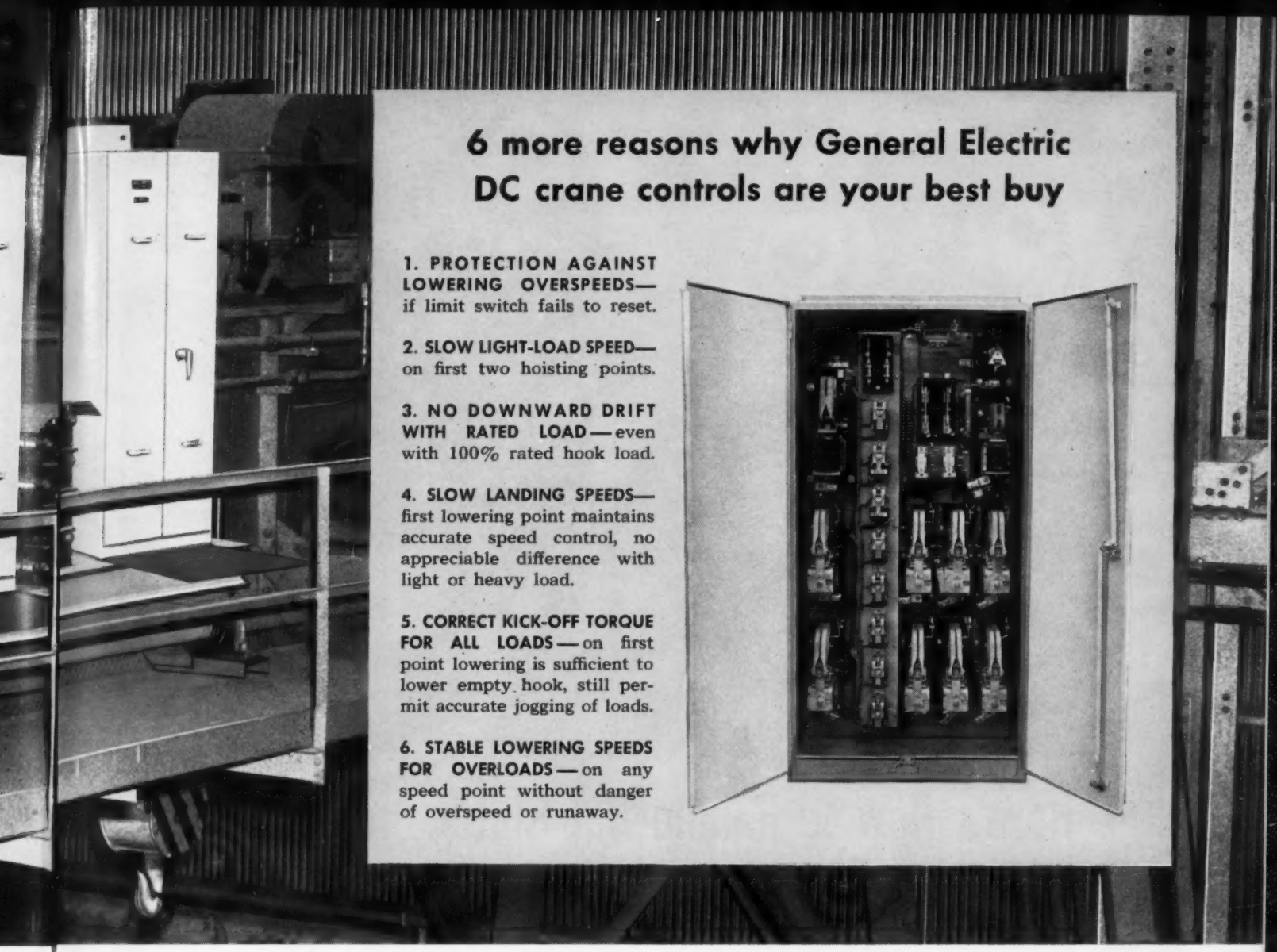

***WITH G-E FRONT-CONNECTED DC CRANE CONTROL***

# Eliminate need for back aisles, reduce

## MD-600 MOTORS . . . the sturdiest, most versatile mill motors on the market



The General Electric MD-600 totally-enclosed armored motor is built for the heavy-duty handling requirements of steel mills. When used in combination with General Electric d-c crane control, you get outstanding performance, minimized maintenance, and your crane-drive lasts longer. The MD-600 motor accelerates heavy loads quickly, handles heavier long-time overloads, and withstands frequent heavy-duty cycles. Maintenance is simplified by the split frame which swings open almost 180 degrees to allow the armature to be lifted straight out. The MD-600's heavy cast-steel frame is sturdy—it's designed to withstand the most severe shock. Since its introduction in 1947, the MD-600 motor has earned its reputation as the sturdiest, most versatile mill motor available.



## 6 more reasons why General Electric DC crane controls are your best buy

**1. PROTECTION AGAINST LOWERING OVERSPEEDS**—if limit switch fails to reset.

**2. SLOW LIGHT-LOAD SPEED**—on first two hoisting points.

**3. NO DOWNWARD DRIFT WITH RATED LOAD**—even with 100% rated hook load.

**4. SLOW LANDING SPEEDS**—first lowering point maintains accurate speed control, no appreciable difference with light or heavy load.

**5. CORRECT KICK-OFF TORQUE FOR ALL LOADS**—on first point lowering is sufficient to lower empty hook, still permit accurate jogging of loads.

**6. STABLE LOWERING SPEEDS FOR OVERLOADS**—on any speed point without danger of overspeed or runaway.



# floor-space requirements 50 percent

General Electric front-connected d-c crane control —introduced in 1957—makes back aisles unnecessary . . . cuts floor space needs by one-half. The modern design—in a smaller cabinet—allows installation on a smaller bridge, permitting closer hook approach to the ends of your building. The control is safer, lasts longer, and needs only minimum maintenance.

General Electric d-c crane control is performing dependably on many heavy-duty jobs—ladle cranes, soaking pits, skullcrackers, and scrap and slab yards. Over 125 hoist controls utilizing this front-connected design are installed and operating reliably.

Check these important benefits of General Electric d-c crane control for the steel industry.

**Less maintenance**—Definite time acceleration and deceleration provide excellent commutation and motor operation of d-c cranes . . . reduce maintenance.

**Greater personnel safety**—All devices are serviced from the front . . . no need to work behind panel.

**Fewer spare parts**—D-c crane controls and mill-drive controls use same devices . . . fewer spares needed.

**Longer equipment life**—Heavy-duty unit bases and picture-frame construction provide long service.

For complete information on General Electric d-c crane control **and** MD-600 crane-drive motors, contact your nearest G-E Apparatus Sales Office or write Sect. 785-12, General Electric Co., Schenectady, N. Y.
*Industry Control Dept., Salem, Virginia*
*Direct Current Motor and Generator Dept., Erie, Pa.*

*Progress Is Our Most Important Product*

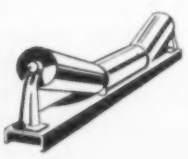
GENERAL ELECTRIC

# Here's How To Handle Hot Sinter Problems!

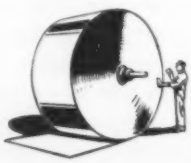
Heat, abrasive dusts, and continuous heavy loading pose special problems in sinter plant operation. Specially engineered Hewitt-Robins equipment, such as this conveyor moving hot sinter to the blast furnaces of a Western steel mill, provides dependable sinter plant operation month after month. Other H-R sinter plant equipment includes:

- Belt Conveyors—Resist abrasion, high temperatures, and withstand the impact and tension of heavy loads and long runs.
- Jones Drives for Feeder Tables—Provide dependable power transmission where continuity of operation affects the entire plant.
- Hot Sinter Screens—Efficiently screen fines with minimum degradation, resist exposure to heat, and give long life in handling abrasive sinter.
- Belt Cleaners—Eliminate a major maintenance job; improve idler and pulley life by keeping conveyor belts clean.

The rugged efficiency of H-R sinter plant equipment is found in all H-R equipment for the steel industry. For full details consult your H-R representative, or write Hewitt-Robins, Stamford, Connecticut. Ask for Bulletin 7-50.

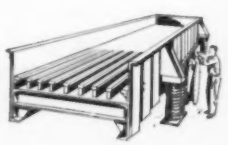


IDLERS



CONVEYOR BELTING

SPEED REDUCERS



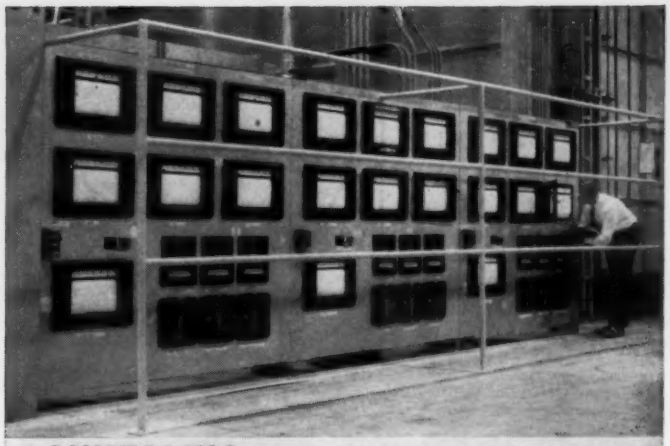
VIBRATING EQUIPMENT

**HR HEWITT-ROBINS**

THE NAME THAT MEANS EVERYTHING IN BULK MATERIALS HANDLING SYSTEMS...

**CONVEYOR BELTING AND IDLERS • INDUSTRIAL HOSE • VIBRATING FEEDERS, SCREENS & SHAKEOUTS • POWER TRANSMISSION EQUIPMENT**

**SOAKING.** These Bristol Dynamaster* instruments monitor soaking pit operation in new, multi-million-dollar aluminum fabricating plant of Anaconda Aluminum Company at Terre Haute, Indiana. Staff engineer analyzes record.



**ANNEALING.** Dynamaster* instruments here control and record annealing furnace temperatures in new Anaconda Aluminum plant. Over 11½ acres under one roof, the new plant produces aluminum sheets, extrusions, tubes and ingots.

**HEAT TREATING.** Anaconda staff engineer checks temperature records, produced by Bristol Dynamaster instruments, for vertical extrusion heat-treating tower, part of which is shown at left.

**AGING.** Dynamaster instrument panel at left controls and records temperatures in aging furnaces in new Anaconda Aluminum Company plant. Furnace operator at right is moving rack car into furnace.

# BRISTOL INSTRUMENTS FOR THE METAL INDUSTRY

*The key to higher quality, more uniform production, greater efficiency*

Bristol offers pyrometers for every requirement: Electronic potentiometers (including miniature models), millivoltmeter and radiation types... for furnaces, ovens... every type of heating equipment, every kind of fuel.

**Bristol Dynamaster* electronic potentiometer pyrometers,** service-tested and proved in thousands of industrial plant installations, fully measure up to the requirements of today's most advanced steel and metal-working plants. Check these modern features:

**1. Continuous standardization**—eliminates usual standardizing mechanism and dry cell... no interruption to control.

**2. Simple, modular design**—few moving parts.

**3. Easy to use and service**—minimum maintenance.

**4. Rugged construction**—continued accuracy and reliability under tough conditions.

Write for complete data—and remember, Bristol markets a complete line of pyrometer accessories available for fast delivery to keep your plant in operation. The Bristol Company, 123 Bristol Road, Waterbury 20, Conn. *T. M. Reg. U. S. Pat. Off. O.8

**BRISTOL** ... for improved production through measurement and control

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

## OIL-HYDRAULIC SLAB & BLOOM SHEARS

The fastest, most flexible and most economical type for cutting forces exceeding 1500 tons.

Pumps with automatically regulated variable displacement supply oil directly to the working cylinders.

Main advantages of this system:

- Smaller initial cost because there is no accumulator!
- Automatic regulation for maximum speed in relation to cutting force!
- Low operating cost as a result of constant high efficiency, independent of cutting section!

3000 t shears of this type in operation at: Dortmund-Hörder-Hüttenunion, Klöcknerwerke A.G. Bremen, Sumitomo Metals Industries Ltd. Japan, HSL Rourkela, Indien, Usines Gustave Boel, Belgien.

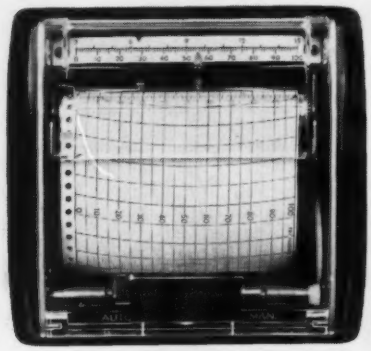
**MASCHINENFABRIK SACK G.M.B.H. DÜSSELDORF · GERMANY**

# Equipment News...

## CASCADE CONTROL UNIT

△ A remote control station containing all the panel-mounted components needed for pneumatic cascade control of a process has been announced by The Foxboro Co. as an addition to its Consotrol line of instruments.

Making use of two Model 58 Consotrol Controllers, the cascade station receives measurements from two different points in the process, recording them on the same chart. Output of the primary controller pneumatically adjusts the set point



of the secondary controller whose output, in turn, operates the valve. This arrangement is required for efficient control of processes with serious lags, such as would occur with a jacketed reactor.

The new station, designed to save panel space, occupies only 6 x 6 in. of panel frontage, compared with the 84 sq in. required by the conventional two stations and subpanel. Automatic/manual switching and adjustment of pneumatic-set values are made at the station where all cascade components, with the exception of a rack-mounted Model 58 secondary controller, are housed.

## SILLIMANITE CEMENTS

△ The Chas. Taylor Sons Co. has announced the availability of new and improved formulations of sillimanite refractory cements, sold under the brand name of "TASIL."

The cements are available in heat-setting and air-setting types, for bonding mullite, high alumina, kaolin, super-duty or fireclay brick and shapes in any high-temperature furnace. Properties of the new formulations include materially improved workability in either dipping or troweling consistency; excellent refractoriness with high bonding strength; superior resistance to slagging or erosion; and negligible shrinkage at high temperatures.

## ADJUSTABLE DRIVES

△ Magnetic drives, in ratings from 75 to 4000 hp, have recently been added to the adjustable speed drive line of the Louis Allis Co.

The drives feature simplified design with few moving parts and provide versatile adjustable speed performance over an automatically regulated 20:1 range.

The drive is based on a liquid cooled magnetic coupling design that features stationary field construction, bearings that can be relubricated without disassembly, and a unique cooling system. The cooling system design permits a planned flow of air through the drive at all times and eliminates any possibility of bearing condensation and drive flooding. Since coolant does not contact the adjustable speed member, "water drag" is eliminated and closer, more uniform speed regulation is obtained throughout its range.

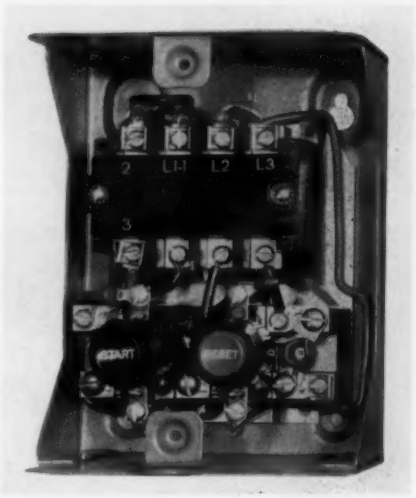
Magnetic drives operate from a-c power and are offered as a complete drive package including drive unit with water controls, controller enclosure and operator's station.

## COMPACT STARTER

△ Cutler-Hammer has announced a low priced, compact Size 00 starter as part of its standard line.

Dimensionally small in size ($5\frac{3}{4}$ in. x 7 in. x $4\frac{3}{16}$ in.), the Size 00 is a magnetic, nonreversing starter which will satisfy approximately 40 per cent of all general purpose applications up to two horsepower better and more economically than larger starters.

Designed for use with both poly-




phase and single-phase motors, the starter is available either as open type or in a NEMA Type 1 enclosure.

Cover control offered consists of "Reset" only; "Start, Stop-Reset" and "three position selector switch." As an optional feature, kits are available for field converting "Reset" only starters to "Start, Stop-Reset" or "three position selector switch."

## "QUICK-CHANGE" TRIM

△ "Quick-change" trim can be replaced in minutes without opening line piping in a new low-noise throttling valve for high-pressure liquid and steam announced by Republic Flow Meters Co., a subsidiary of Rockwell Manufacturing Co. Maintenance time is cut because the valve plug, guide and seat can be replaced in little more time than required to open and close a bolted joint.

Designated the V-10, the new valve is designed for severe service, where pressure drops may be as high as 3500 lb or where flashing may occur.

The valves are angle-style, diaphragm-operated, and are available in 1500-, 2500- and 4500-lb classes, from $1\frac{1}{2}$ through 4-in. sizes. The V-10 is designed for flow control where high pressure drops or flashing occurs.

"Quick-change" trim is available

in the 1500- and 2500-lb classes. Flex-Seal seats are available in 1500-, 2500- and 4500-lb classes.

Quiet operation results in the new valve from flow being parallel to the internal valve surfaces. This induces uniform velocities and reduces impingement of fluid.

The valve body is protected from wear by an extended diffuser section on the seat and by contouring of throttling surfaces. This limits erosion and cavitation to the trim components.

Trim can be selected for linear, equal-percentage, straight-taper or shut-off response. Other optional specifications include bolted bonnet in 1500- and 2500-lb classes, pressure-seal bonnet in all classes, socket-weld and flanged ends in 1500- and 2500-lb classes, and butt welded ends in all classes.

Corrosion-inhibiting asbestos and teflon packings are available. Accessories include handwheels, valve positioners, air locks, and air filters, air regulators and air gages.

***The revolutionary Bliss Pulsation Burner***

produces temperatures never before achieved with oil or natural gas. Burning oil, it can reach a searing 3450°F. On 1000 BTU/cu. ft. natural gas, it develops 3320°F. Both these extremely high temperatures are close to the theoretical limits for these two fuels. Foundries, smelters, heat treaters and other metal processers have been quick to take advantage of the remarkable combustion efficiency of these new burners. To them, it has meant faster heating cycles, cleaner flue gases, and above all, fuel economy that cuts from 12% to 30% from their furnace overhead. Not to speak of reduced maintenance on refractory linings.

To learn how the Bliss Burner can increase the heat output in your plant while it's saving you money in fuel and furnace maintenance, write today for our Bulletin No. 60. It's yours for the asking.

BLISS
SINCE 1857

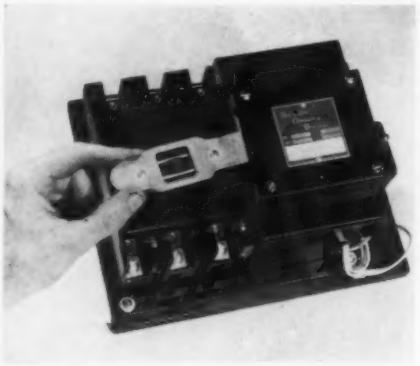
**E. W. BLISS COMPANY**
**Canton, Ohio**
*BLISS is more than a name—it's a guarantee*


## ELECTRICAL OPERATORS

△ A line of electrical operators that allows Type AB circuit breakers to be remotely controlled is now available from the Westinghouse Electric Corp.

Models with rated control voltages of 120, 240, 480 or 600 volts alternating current and 125 volts direct current can be supplied. They will actuate breakers rated to 100 amp at 600 volts in frame sizes designated E, EH and F.

The electrical operators can be used for a variety of remote control applications involving equipment such as engine generators, battery chargers, irrigation and oil field



pumps and lighting. They can also be used for capacitor-bank switching, as a limited duty motor starter, or as an overload sensing device.

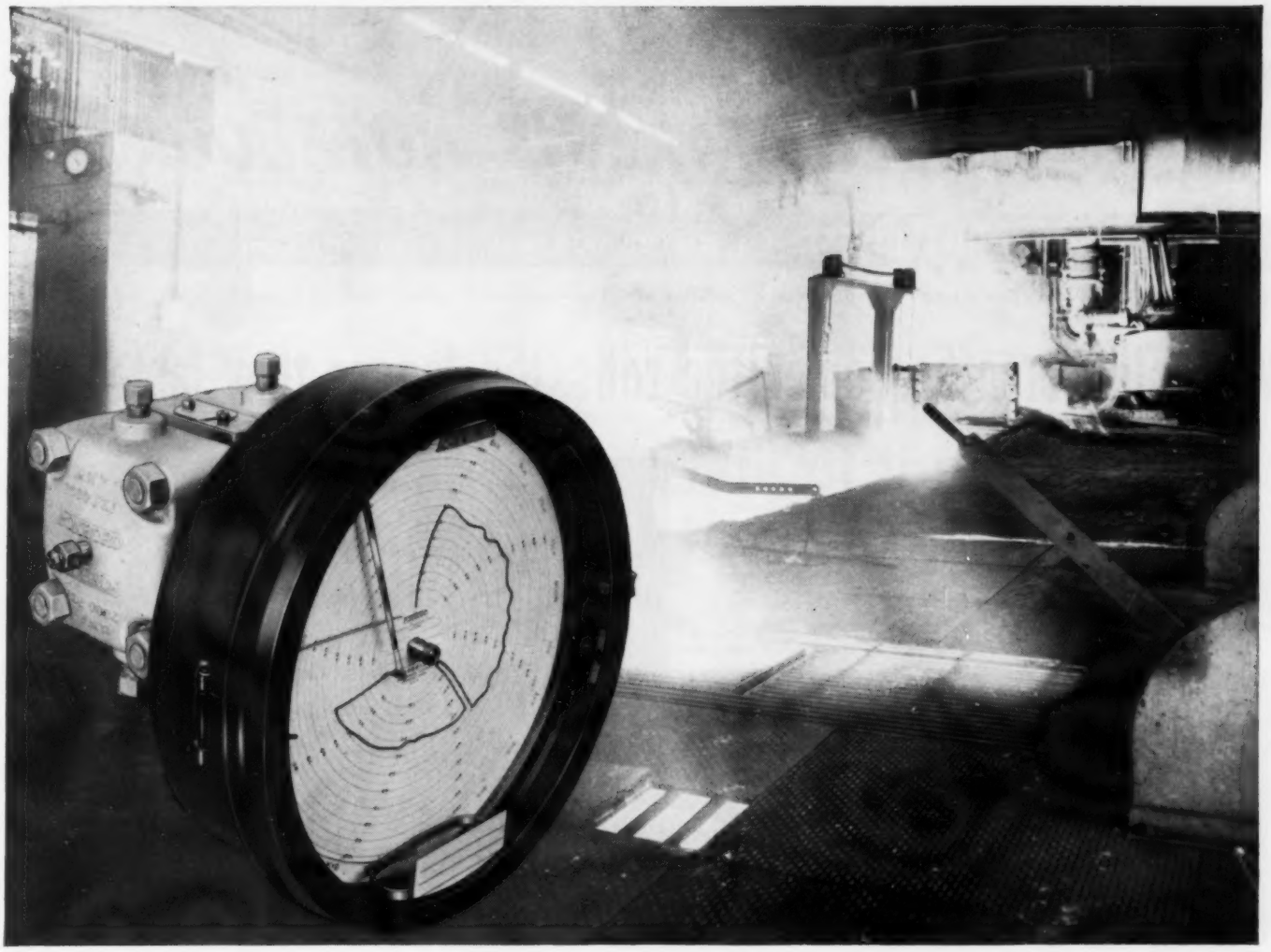
Breakers that are mounted on panel boards, switchboards or bus-duct plug-in units can be equipped with the new electrical operators. For easy installation, mounting holes for the operators are identical in spacing and size to those for the breakers in all of the three available frame sizes. For back mounting, a special pin can be supplied.

An electrical operator does not impair overload protector features of a breaker, nor does it prevent the breaker from being manually operated.

## SEMI-SILICA BRICK

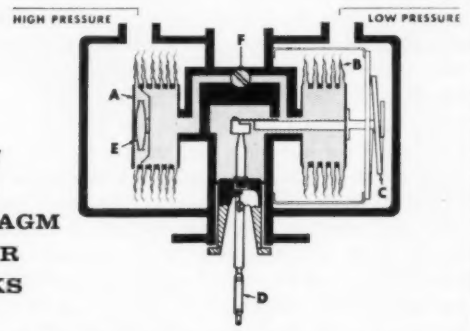
△ Refractories Division, H. K. Porter Co., Inc., has begun production of a new semi-silica refractory brick, "Sem-Sil," for continuous service at operating temperatures up to 2600 F or more in metallurgical and ceramic furnaces.

Made by the dry press method, it contains approximately 75 per cent silica. Principal applications are in roofs of hot metal mixers, roofs and



# Dirty gas can't foul this flow meter

**HOW THE DIAPHRAGM METER WORKS**




In the schematic drawing above, areas shown in gray represent a stable, non-freezing liquid which never comes in contact with the process fluid. Any pressure increase in the high pressure chamber compresses diaphragm unit A, displacing its liquid and expanding diaphragm unit B until the force of range spring C equals the difference between the forces of the two diaphragm units. Linear motion of diaphragm unit B moves inner end of drive bar D — outer end moves correspondingly through the bellows – sealed flexure bar, driving pen arm.

Blast furnace gas, coke oven gas, natural gas, steam, water — you can measure them all with the Foxboro Type 37 Diaphragm Flow Meter and never worry about mercury contamination.

That's because the Diaphragm Meter has *no* mercury. In this meter, expansible Type 316 s.s. diaphragm elements convert differential pressure into accurate, dependable pen arm motion — automatically compensated for ambinet temperature effects. There's no mercury to clean or replace — no loss of accuracy due to clogging.

Even with dirty gas, the exclusive design of the Foxboro Diaphragm Meter's range-springs and diaphragm elements assures lowest maintenance — highest sustained accuracy of any "dry" meter.

The Type 37 handles flow measurements over a wide range of differential pressures — at static pressures up to 2000 psi. Get full details by writing for Bulletin 7-15. **The Foxboro Company, 587 Neponset Avenue, Foxboro, Massachusetts.**

**FOXBORO**
REG. U.S. PAT. OFF.
***FIRST* IN FLOW METERING**

# TIPS FROM A ROLL MAKER'S NOTEBOOK

**MACKINTOSH-HEMPHILL DIVISION, E. W. BLISS COMPANY, Pittsburgh 3, Pennsylvania**

Cast mill rolls • Johnston cinder pots • rotary tube straighteners • end-thrust bearings • heavy-duty lathes • steel and special alloy castings

## With slabbers, the cooler the rolls, the longer they last

We have been somewhat concerned during the last year or so by what seems to us a more than normal number of premature roll failures in universal slabbing mills. These failures have not been limited to any one brand of rolls.

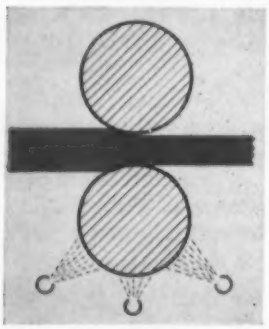
As a result, we have been checking among the many users of universal slabbers of our acquaintance, and in particular, with the operators whose mills have been giving them good outputs between roll replacements.

We think we have the answer to part of the problem, and will pass it along to you. Even if you don't operate a slabbing mill, you may find it helpful in connection with hot mill operation in general.

**Not enough water.** In every troublesome case that has come to our attention, too little cooling water was reaching the bottom roll, either because of an inadequate cooling system, or clogging of the spray header. Here is the way two steel plants are currently taking care of the problem:

*CASE A:* Water is applied to the top roll by means of a water box, with wipers on both entry and delivery sides. Three 4-inch pipes spray the bottom roll, one directly beneath the roll and the other two on the entry and delivery sides. When this mill was first installed, it had only one pipe directly beneath the bottom roll, which resulted in frequent roll breakage.

This mill is particularly careful about bringing the rolls up to working heat before beginning production. Standard practice is to pass two ingots three or four times through the mill, taking very mild reductions, with the water valves opened only half way. The two "start-up" ingots are then sent back to the soaking pit, the water is turned up to full pressure and a new, hot ingot is brought up to start the turn's regular production run.



**Good blooming and slabbing mill** roll-cooling arrangement utilizes two or more water lines to the bottom roll, which is usually the first to show signs of premature failure.

*CASE B:* This mill as delivered had only one spray header underneath the bottom roll. Bad fire cracking and roll breakage occurred almost from the day the mill was placed in production. Study of the mill showed that scale was lodging between the water pipe and the bottom roll, so that little if any cooling water was reaching the roll. Two additional water lines were brought in, each delivering its water about half way up the side of the roll. The general problem has been effectively solved by this expedient. Today, this mill at times rolls up to 140,000 tons before the rolls are redressed although normal practice is to change rolls after approximately 75,000 tons.

**This is the mill** described in Case A; it has an excellent record, thanks to careful control of heat in the rolls and the avoidance of sudden temperature changes.

Mack-Hemp has evolved a number of roll analyses that are especially good for slabbing and blooming work because of their combination of strength and resistance to fire cracking. Mack-Hemp *Technalloy* rolls cast from chrome-moly steel and specially heat treated offer excellent resistance to fire cracking and breakage under the most severe operating conditions. Mack-Hemp *Superalloy*, a nickel-chromium-molybdenum steel roll, turns in outstanding performance in blooming mills where side wear and fire cracking in the passes has been severe.

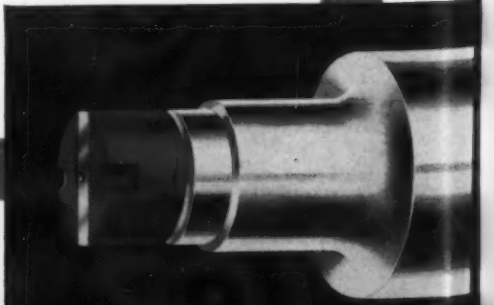
Whatever your problem of roll use, you'll find that Mack-Hemp can provide useful advice or helpful suggestions. We've been accumulating data on roll performance for more than a century and a quarter . . . it's yours for the asking. 'Phone or write us at any time.

**MACKINTOSH-HEMPHILL**

*You get more tonnage from the rolls with the Striped Red Wabblers*

**Division of E. W. BLISS COMPANY**

**Presses, Rolling Mills, Special Machinery**

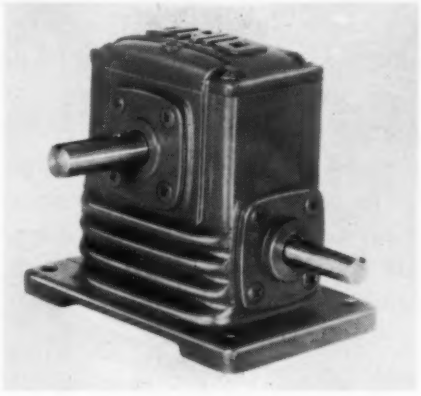


sidewalls of heating furnaces, sidewalls of open hearth regenerators, blast furnace stove domes and sidewalls, soaking pit sidewalls and roofs and in ceramic tunnel and periodic kilns.

Outstanding features are unusual volume stability and load bearing ability at top operating temperatures, and excellent resistance to structural spalling. In the presence of alkali vapors, a protective glaze forms on the hot face of the brick which prevents penetration of furnace gases into the refractory brick and resultant damage.

## SPEED REDUCER

△ The Ohio Gear Co. has announced a new model fin and fan cooled worm and gear speed reducer designated the Series S-13. The unit is designed for horizontal right angle drive with the worm below and is capable of delivering up to 80 per cent more capacity than comparable nonventilated models of equal size. The increased capacity is reflected in far smaller space requirements for the new reducers. It employs a worm and gear reduction



and features heavy duty ball bearings in all shafts.

The Series S-13 is a highly versatile model developed to accommodate a wide variety of design situations. It features heavy bearing capacity, shorter center distance between worm and gear and improved heat dissipation characteristics.

The reducer is available in a complete range of sizes from 1.33 to 5.25 in. center distance. Ratings range from $\frac{1}{16}$ to 18 hp.

## ELECTRIC INTEGRATOR

△ For precise integrating of flows that can be represented by a d-c electrical signal, GPE Controls, Inc., offers the new Model R 790 Electric Integrator. Although designed for use with the company's linear signal electric flow transmitters, the instrument can be used for integrating any quantity that can be linearly represented by a d-c voltage or current signal in the 0–25 volt range. This could include positive displacement fluid motors driving tachometers, lineal measurement of webs and strips, etc.

Integration is continuous and accurate to within $\frac{1}{2}$ of 1 per cent with flow turndowns of as much as 10 to 1. Chart planimetering is eliminated by the direct 6-digit read-out. The instrument is insensitive to temperature changes between −30 and +130 F. Front panel space of only about 3 x 3½ in. is required.

A d-c motor, with speed proportional to the applied voltage, drives the precision gear train and counter. The motor has jeweled bearings and precious-metal commutator; its output is much greater


"Rod Mill of the Century" installs more than a hundred Lintern GLOWLITES

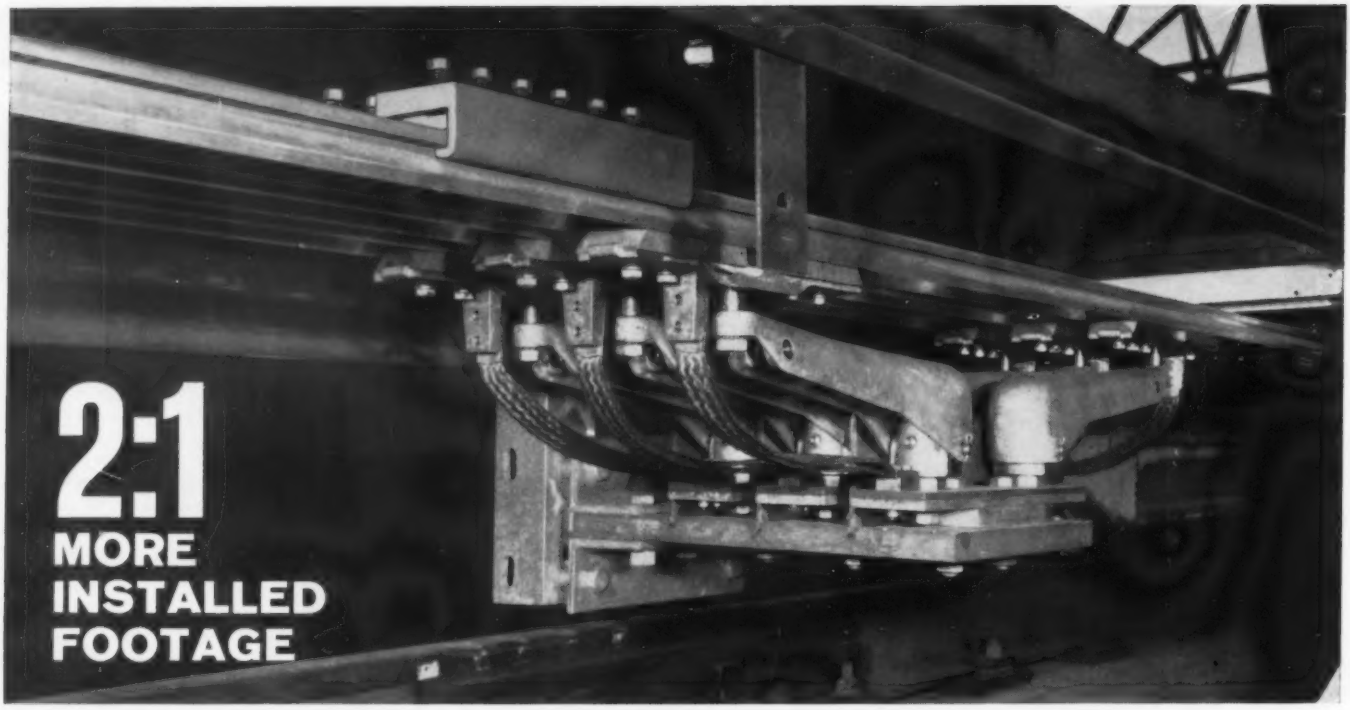
...plus two Lintern Pulpit Aire Rectifiers

Nothing was spared to make this Sheffield No. 2 Rod Mill at Kansas City one of the most efficient rod mills in the world.

With rod traveling at speeds up to 74 MPH, Sheffield has made certain its operators are comfortable and alert . . . Not only are two pulpits air conditioned with Lintern Aire Rectifiers, but 108 Lintern Glowlites mounted on a huge panel visible throughout the mill, give clear warning the moment a lubrication problem develops on high speed production equipment.

*Contact your local Larco representative or write:*

Larco, inc.
DISTRIBUTOR OF LINTERN CORPORATION PRODUCTS
ROUTE 20 EAST • PAINESVILLE, OHIO




Inverted V-Type conductor extrusion gives protected contact surface. Collector design provides for low current density—minimizes arcing and heating.

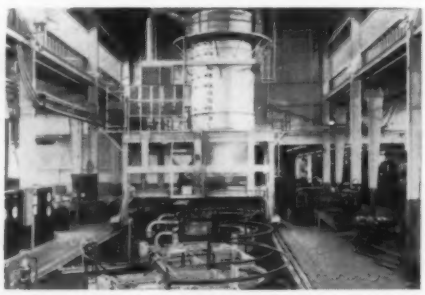
# SUPERIORITY OF DELTA-STAR INTEGRATED DESIGN PROVEN BY OVERWHELMING CUSTOMER ACCEPTANCE

Operating in all kinds of atmospheres, more footage of *fully engineered* Delta-Star Integrated Aluminum Crane Conductor-Collectors are installed than all competitive makes combined.

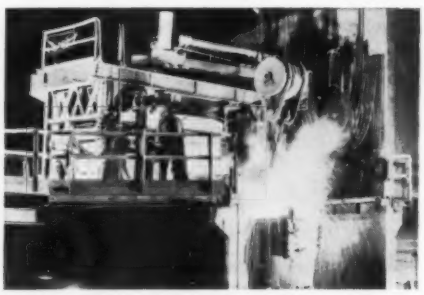
Delta-Star aluminum systems are easily installed, space-saving, and are corrosion-resistant. They eliminate the need for copper boosters, and reduce voltage drop. In the high ambient and corrosive conditions typical of blast furnaces, ship yards and other industrial applications, Delta-Star systems have provided efficient performance with low maintenance.

Integrated Aluminum Systems are available with continuous ratings of 500, 1000, 2000, 3000, and 6000 amps. For special applications, bronze and copper systems also are available with ratings from 450 to 2000 amps. For more complete information on the finest *fully engineered* crane conductor systems available, write to *Delta-Star Electric Division, H. K. Porter Company, Inc., 2437 W. Fulton Street, Chicago 12, Illinois.*

Ship yard installation defies extremely corrosive salt air.



Traveling gantry type furnace at a mid-western steel treating company.



Blast furnace installations withstand high ambient temperatures.

**DELTA-STAR ELECTRIC DIVISION** PORTER **H. K. PORTER COMPANY, INC.**

**PORTER SERVES INDUSTRY** with steel, rubber and friction products, asbestos textiles, high voltage electrical equipment, electrical wire and cable, wiring systems, motors, fans, blowers, specialty alloys, paints, refractories, tools, forgings and pipe fittings, roll formings and stampings, wire rope and strand.

than that required to drive the gears and counter, insuring long-time accuracy and dependability.

## CONTROL PANELS

△ As much as 35 per cent less floor space is required by General Electric Co.'s improved control panel equipment for steel mills. Isolated power wiring, easier installation and dead-front construction are other benefits of the redesigned line, according to the company's Industry Control Department.

More efficient arrangement of control components allows the new panels to be "bigger on the inside, smaller on the outside." Wider and unobstructed maintenance aisles between front panel and back rack are now possible, even though important savings are achieved in total floor space occupied by the control.

Wider aisles, equipped with fluorescent lighting where required to eliminate shadows, increase personnel safety and speed up installation and maintenance. Floor space reductions conserve valuable floor space in existing mills and help reduce construction cost in new building.

Control adjustments are easier to make on the redesigned panels. Vernier adjustments are located next to their related meters. All control relays and regulating circuits are adjusted from the front of the panel.

Dead-front construction provides added protection for operating personnel. Packaged regulators are used, and relays, contactors and other front-panel devices are mounted behind doors. Packaging of equipment into functional components gives longer trouble-free operation and greatly improves panel appearance and "housekeeping."

Reliable static devices such as amplistats, reactors and capacitors, which require no adjustment, are mounted on the rear of the regulating package behind the front panel. Here they are out of the way, yet accessible should replacement be required.

All incoming wires for control terminate at the front of the control panel.


**DRAVO DISCS**
**offer these plus values for pelletizing and mixing . . .**

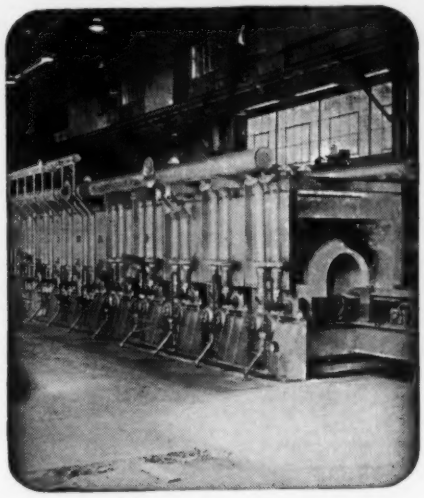
- Pellet uniformity is far superior to that produced by other methods.
- Continuous operation (not batch) assures higher production rates.
- Binder is unnecessary in many cases.
- Low overall cost per ton of output.
- Material in process can be viewed continuously.

Send for Bulletin Number 247. Write Dravo Corporation, Pittsburgh 25, Pennsylvania.

Manufactured under license agreement with Lurgi of Frankfort, Germany.

**DRAVO**
CORPORATION

**SPEED HEATING SAVE SPACE IMPROVE QUALITY**
**WITH HI-HEAD**



**R-S HI-HEAD HEATS 25 TONS SLAB PER HOUR . . 75% LESS FLOOR SPACE . . ONE FOURTH LABOR**

Now, heating of 25 tons of stainless steel slabs per hour is a continuous operation at Atlas Steels Ltd. The R-S Hi-Head Furnace reaches a high heat fast and maintains it uniformly in all parts of the furnace for the complete cycle. Heating time is reduced . . . there is no overheating of slab edges . . . and uniformity is assured on every piece. Labor is one-fourth that required on conventional furnaces. Floor space used is 75% less.

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# New Side Trimming Line Installed In Tin Mill Will Improve Production Of Tinplate In Coils

## Installation Called Most Modern Of Type In Industry

A new side trimming line to facilitate the production of tinplate in coils in Weirton Steel's Tin Mill Department was placed in operation recently.

W. H. Wright, Vice President and Chief Engineer, said the new installation, rated among the most modern pieces of equipment in the steel industry, was installed because of the increasing demand from customers for tinplate in coil form. The company will also continue to ship tinplate in the conventional cut sheets.

The new side trimming line, which began operating last month, and a second line, installed on an emergency basis, are used to trim the sides of the sheet steel before it is plated with tin, so it can be wound into coils and be ready for shipment as it comes off the tinning lines.

Mr. Wright explained that Weirton Steel's No. 4 and No. 5 tinplating lines have been equipped with edge control reels which insure that each coil is wrapped with a straight edge. This is necessary to prevent damage to the edges in bundling and shipping and also because straight edges are required when the coils are processed further by Weirton Steel customers.

Mr. Wright also reported the installation of a new bundling line, which began operating about three months before the new side trimmer. The bundling line utilizes machinery to wrap coils in heavy paper and fasten them with steel straps. Formerly, this was a hand operation.

The side trimming operation takes place after the steel has been tempered to customer specification by the skin mills and before it is plated with tin. This process eliminates the waste which formerly resulted when the side trimming was done on the cutting lines, after the tinplating process.

The No. 2 side trimming line has a maximum speed of 4,000 feet per minute while the No. 1 line operates at a speed of 1,200 feet per minute. The No. 2 line is able to handle 30-ton coils 85 inches in diameter and 45 inches wide. The line also is equipped with a mash welder, a relatively new operation which provides a smoother weld that does not damage other sections of the coil as it is wound.

All of the new facilities were designed by the Weirton Steel Engineering Department and installed by the company's Construction Department.

Reprinted from Employees Bulletin, Weirton Steel Company, February, 1960

Due to increasing demands from customers for tinplate in coil form, a new side trimming line was installed recently in the Tin Mill. The new trimming line, designed by Weirton Steel's Engineering Department and installed by the Construction D[illegible] the [illegible] of sheet steel bef[illegible]ted with tin


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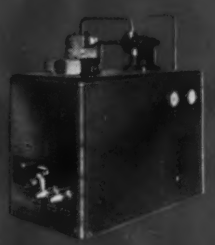

GPE Controls Model 300 Edge Control, as furnished to Weirton Steel Company.

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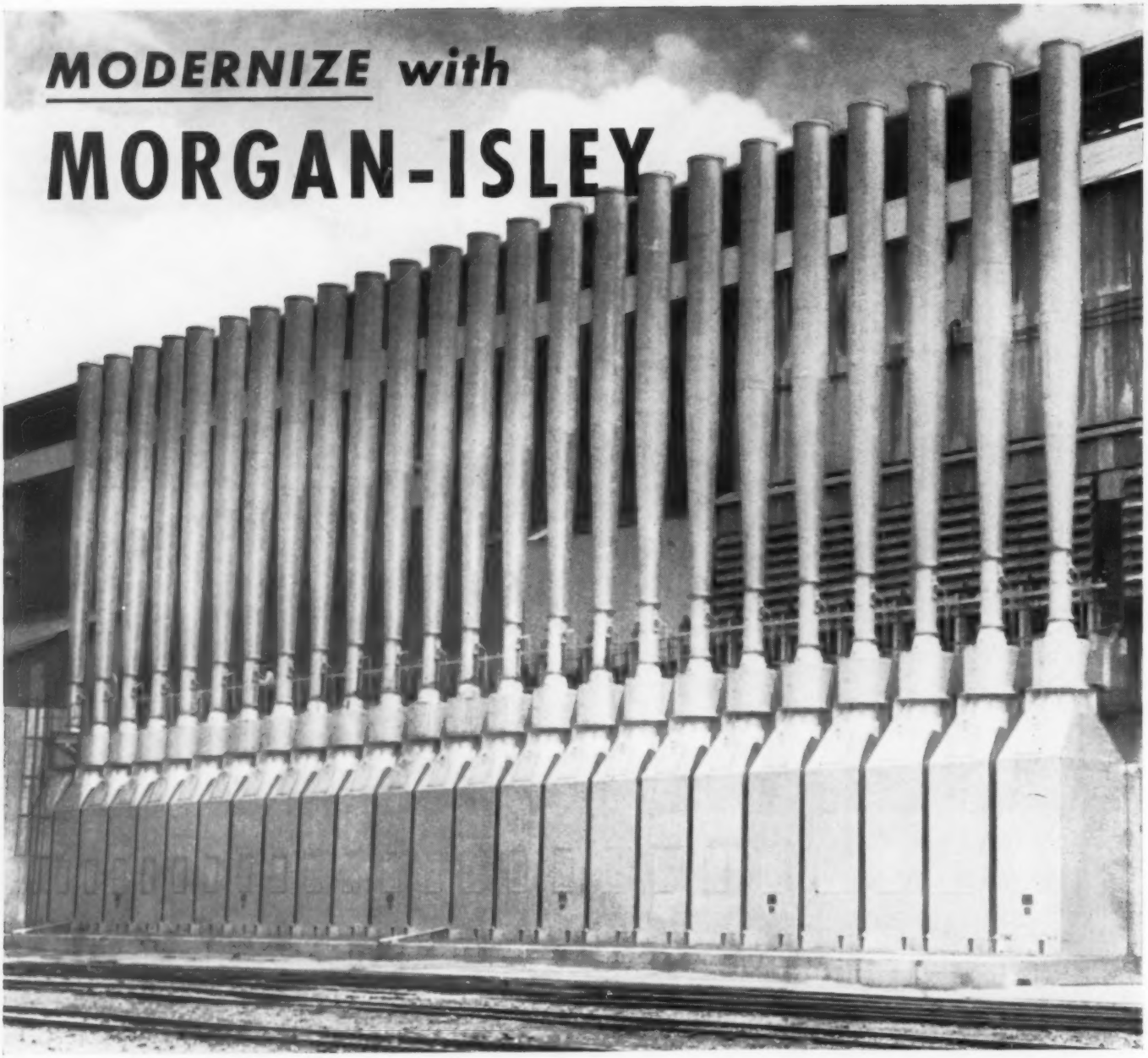

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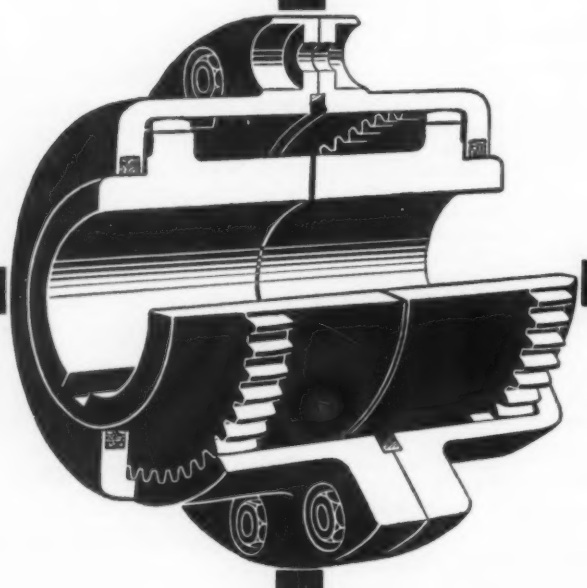

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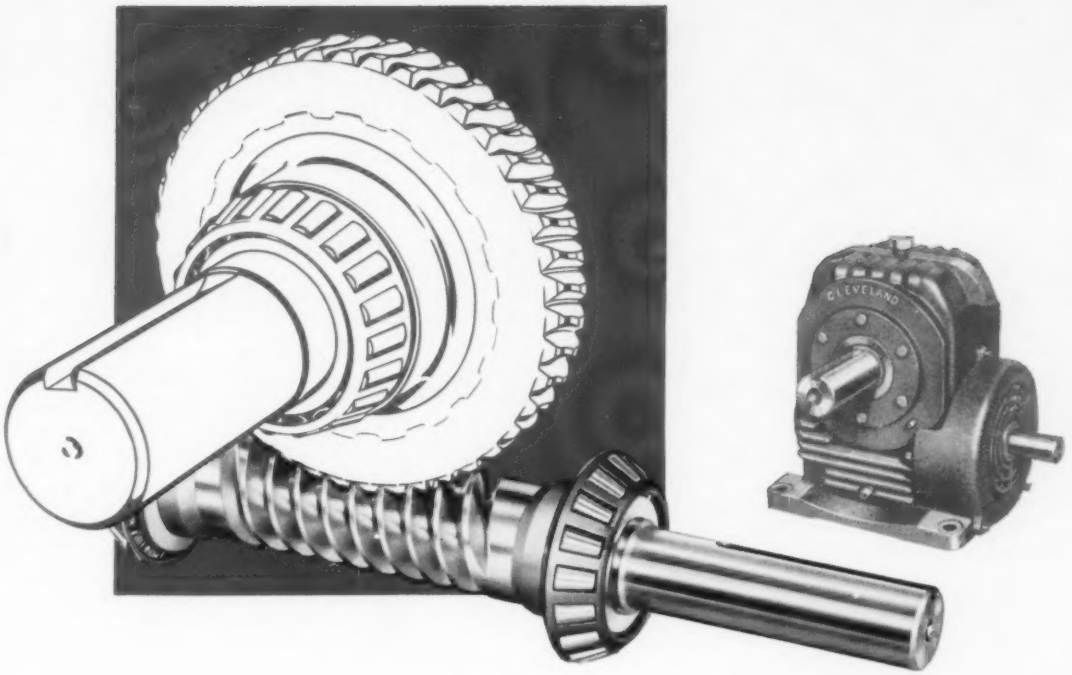


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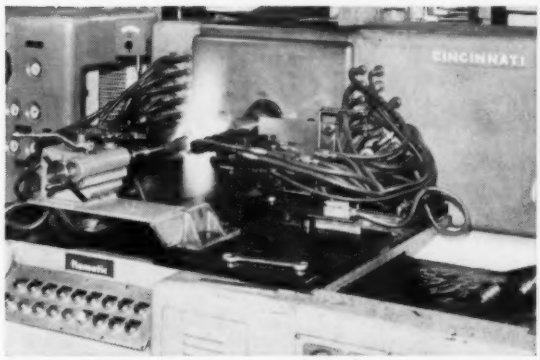


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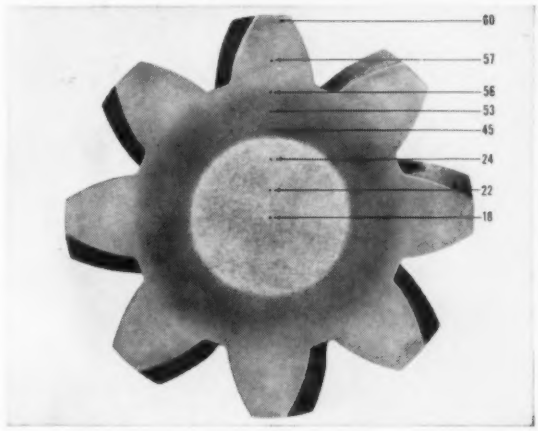


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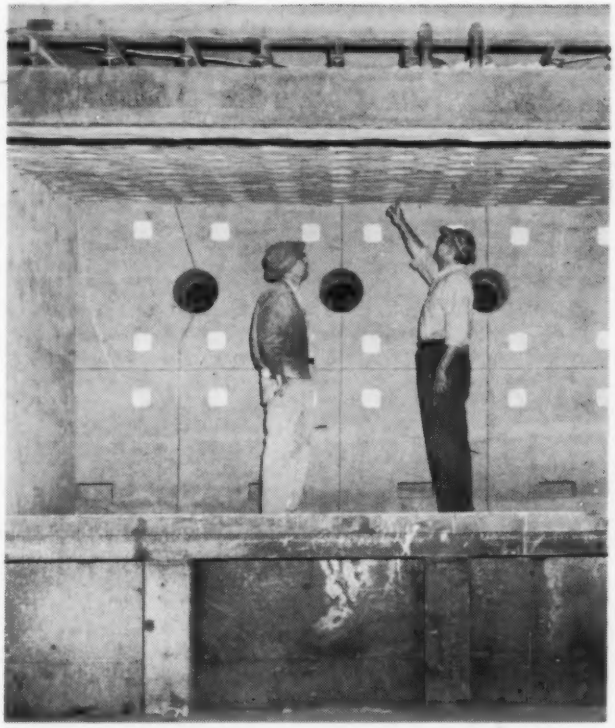

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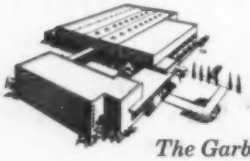

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